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SHERIDAN BAKER

PART I. NATURAL SCIENCE

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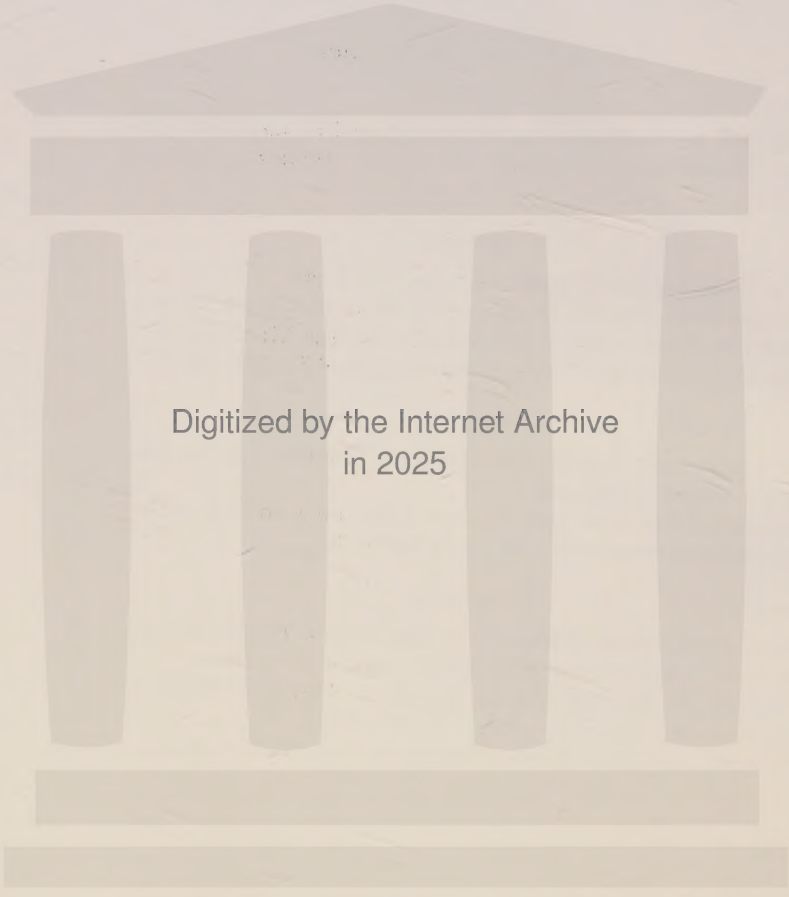

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PART I. NATURAL SCIENCE

BOTANY

Papers of the Michigan Academy of Science, Arts, and Letters
Vol. XLII, 1957 (1956 Meeting)

NEW RECORDS OF VASCULAR PLANTS FROM THE DOUGLAS LAKE REGION (EMMET AND CHEBOYGAN COUNTIES), MICHIGAN[1]

EDWARD G. VOSS
University of Michigan

In Volume 4 of the *Papers of the Michigan Academy*, Frank C. Gates and John H. Ehlers (1925) presented an annotated list of the higher plants found in the two-county region around the University of Michigan Biological Station, at the northern end of the Lower Peninsula of Michigan. Supplements were published in 1928, 1931, and 1948.

The Gates and Ehlers list became widely known and frequently cited, for there are relatively few such accounts of floristics in the northern Great Lakes region. Before a completely new list can be prepared, it seems desirable to continue to keep the work of Gates and Ehlers up to date.

The previous lists were based almost entirely on the work done at the Biological Station and did not attempt to present a comprehensive report on the regional flora derived from earlier work of others as represented in the literature or in herbaria. Seldom, even, were citations of their own collections in monographic works listed by Gates and Ehlers when these would have been additions to the regional flora. In working toward a new list, I have attempted to account for all previously published records for the region and to study relevant herbarium material (so that no species is admitted to the list unless I have examined an actual herbarium specimen). The present list of additions, therefore, includes a considerable share of older records besides those which have naturally accumulated since the final Gates and Ehlers supplement (1948).

An account of botanical history in the region, with full bibliography and an annotated list of those species reported in the literature but for which no accurately determined specimens have been found, is being published separately (Voss, 1956). It seems unnecessary to repeat here the background material, statements concerning im-

[1] Contribution from the Biological Station of the University of Michigan.

portant collectors, list of references, and similar material in this companion paper.

The criteria for inclusion of species on the accepted list may well be again summarized, however. All species are accepted for which there are authentic specimens in herbaria so long as there are no indications on the label (or in published statements) that the collection represented a population growing under cultivation or directly persisting from cultivation. This means that (so far as the known evidence goes) an included species must at the time of collection have been reproducing itself or growing from seeds which were not planted.

The present list differs from those of Gates and Ehlers by presenting new records only for the entire two-county region. Individual new records for each county would extend the report to unmanageable length. This list does supplement those of Gates and Ehlers, however, in that records are included for all species which they did not list—even the few which have been previously published elsewhere, as it has seemed useful to gather into one supplement the scattered records from the literature of the past half-century if these are verified by specimens. (The unverified reports, including those of Gates and Ehlers themselves, are accounted for in the companion paper previously cited, and reference to them is made here only if the correct determination for a misidentified collection is an addition to the list for the region.)

Only *species* new to the region are included. Additional varieties and forms are not mentioned, since the space required would be considerable and since the importance of many infraspecific entities is not agreed upon by botanists. If a new record for a species can be clearly placed in a particular variety, however, this may be mentioned below. But it should be emphasized that failure to cite a variety does not necessarily mean that the nomenclaturally typical variety is implied; only if the specific epithet is repeated in varietal rank may this be assumed.

In their final supplement, Gates and Ehlers (1948, p. 46) gave the total number of "species and varieties" in the region to be 1226. This figure (as in their previous statistical summaries of "species") evidently includes species, varieties, forms, hybrids whether named or designated by formula, and new names for species already reported under other names. As a consequence, the figure is quite

meaningless.[2] As my records now stand, the regional list includes 876 indigenous species and 307 non-indigenous ones. Since three species are represented by varieties in both categories, the total number of *species* is 1180 (based on a fairly conservative concept of species). Many are represented by more than one named variety or form, but these have not been tabulated. Approximately 40 of the species considered non-indigenous in our flora are native within a few hundred miles or less, but because of their occurrence as an occasional roadside or railroad waif or an apparent escape from cultivation it seems best to consider them adventive or introduced in the Douglas Lake region. In addition to the 1180 species in the region, more than 20 hybrids have been identified and, if new to the region, are reported below by formula or, wherever possible, by a binomial.

Collectors cited most frequently are identified by initials as follows:

H.C.B.: H. C. Beardslee
E.U.C.: E. U. Clover
J.H.E.: J. H. Ehlers
C.W.F.: C. W. Fallass[3]
F.C.G.: Frank C. Gates
C.A.K.: C. A. Kofoid
R.McV.: Rogers McVaugh
E.G.V.: E. G. Voss
W.H.W.: W. H. Wagner, Jr.
C.E.W.: C. E. Wood, Jr.

[2] Blake (Rhodora, 56: 62–63 [1954]) issues a long-needed protest against the often misleading picture of a flora which is gained from a statement of the number of "species and varieties" which it contains. One immediately wonders, How many are species and how many varieties? Varieties according to whose taxonomic concepts? Especially in comparing floras of geographic areas which have received taxonomic study of widely differing intensity and refinement, the lump sum "species and varieties" tells us little of what we want to know concerning the size of the flora.

[3] Fallass is cited as collector if no other designation appears on his labels, although he did not always enter his initials in the space for "collector." His numbers are not cited, since he apparently had separate systems for specimens and herbarium sheets, and it is often impossible to tell which is recorded on a label. (Often there is no number at all on a label.) For an account of the life of C. W. Fallass and his herbarium, which is now at Albion College, see Voss, 1955. Fallass and C. H. Swift in 1918 prepared a manuscript list of the flora of the region, largely Emmet County, and this is frequently quoted in the notes which follow. Fallass and Swift's references for species which would be new regional records are not reported herein, however, unless the occurrence of the species is supported by actual specimens—in the Fallass herbarium at Albion, or elsewhere. (If the supporting specimens are elsewhere, the statements from the Fallass and Swift list are given for whatever value and interest they may have, but it should be emphasized that, when specimens at Albion are not cited, the basis for the Fallass and Swift listing is not known and may have represented a misidentification.)

Abbreviations for institutional herbaria follow the second edition of the *Index Herbariorum* (Lanjouw and Stafleu, 1954) or recommendations for inclusion in the third edition (Stafleu, *in litt.*, 1956):

ALBC: Albion College
BLH: Cranbrook Institute of Science
MICH: University of Michigan
MSU: Michigan State University
OC: Oberlin College
SMU: Southern Methodist University
UMBS: University of Michigan Biological Station

In the list below, the name of each species is followed at the right margin by an indication of the county or counties from which it is being reported: E. = Emmet Co., and C. = Cheboygan Co. In order that the basis of the reports may be easily known and the specimens located by any who may be interested, collections are identified by collectors' initials and number (if any), followed by the abbreviations of herbaria in which specimens are deposited.[4] (EGV = my personal herbarium, at Mackinaw City, Michigan.) If a species is common in the region, such complete citation is generally dispensed with; nor is it given if the species is here reported under the correct name for material previously misdetermined but already reported by Gates and Ehlers. When collections from both counties are cited, those for Emmet County are given first and are separated by a long dash (—) from the Cheboygan County citations, which follow. For my own collections, at least, distances from towns are straight-line distances as measured on maps[5] and are not auto mileages by road.

[4] In the case of some collections, especially in the ferns, it has not been possible to cite herbaria, as distribution of material collected for study has not been completed. All herbaria to which collections of a given number have been, or will be, distributed are not necessarily cited; McVaugh's collections, for example, are often represented by several sets which have been widely exchanged.

[5] Maps were not included by Gates and Ehlers and are omitted here. A general map of each county is in a companion paper (Voss, 1956). Excellent detailed maps of each county may be obtained from the Department of Conservation in Lansing and are a necessity for anyone contemplating field work in this area, for which topographic maps are not available. The Emmet County Road Commission, Petoskey, distributes a very good map of that county—one which has added usefulness for its indication of political township boundaries, making it easier to describe localities. The "Official Map of Cheboygan County" available in Cheboygan is so full of assorted omissions and positive errors regarding roads and trails that it is a danger to the field

Acknowledgments

I am under special obligation to the following specialists who have generously determined material for me in the groups for which they are recognized authorities: Warren H. Wagner, Jr., Pteridophytes; Eugene C. Ogden, *Potamogeton*; Frederick J. Hermann, *Carex*; Donovan S. Correll, Orchidaceae; Carleton R. Ball, *Salix*; Ernest J. Palmer, *Crataegus*; N. H. Russell, *Viola*; L. H. Shinners, *Aster* and miscellaneous species; Robert W. Long, Jr., *Helianthus*. In addition to those to whom I have sent material for checking, a number of botanists have annotated specimens from the region under other circumstances, and their work has of course made mine easier. Unless the name of a specialist is specifically mentioned, however, it is not to be assumed that he has necessarily examined the material cited below, with the exception of the Pteridophytes, all the records for which have been checked by Wagner. The opportunity to work at the University of Michigan Biological Station with Rogers McVaugh, Carroll E. Wood, Lloyd H. Shinners, and Warren H. Wagner has been a valuable and useful experience; their annotations on material in the Station herbarium, as well as comments in the field, have been most helpful. It has been a special encouragement to have had the support of the late Frank C. Gates in my study of the local flora with which he was so long associated.

For extending to me every courtesy when visiting for study the herbaria under their care I am indebted to those in charge at Albion College, Cranbrook Institute of Science, Michigan State University, and Oberlin College.

For financial assistance which has made possible the prosecution of my studies and field work[6] to date, I am grateful for summer teaching assistantships in systematic botany at the University of

collector; it is useful for determining the boundaries of political townships and for locating sections (if one is not misled by erroneous location of roads).

NOTE: A completely new "Official Map of Cheboygan Co." was issued in 1956 in co-operation with the Consumers Power Co. It is a vast improvement over previous editions.

[6] Field and herbarium studies prior to 1954 were utilized in preparation of a working list of the local flora, which was analyzed for distribution patterns and possible post-glacial history in a thesis presented to the Horace H. Rackham School of Graduate Studies, University of Michigan, in partial fulfillment of the requirements for the degree of Doctor of Philosophy, June 1954.

Michigan Biological Station; for an assistantship, teaching fellowship, and the Emma J. Cole Fellowship in the Department of Botany, University of Michigan; for a Denison University Research Foundation Scholarship; for support from the University of Michigan Botanical Gardens and from the herbaria of the University of Michigan, the Biological Station, and Southern Methodist University.

New Records for the Region[7]

Equisetum pratense Ehrh. E. C.

Although first reported for the region by Winchell (1861, p. 315), no specimens seem to have been made until almost 90 years later. Beech-maple woods near Cross Village, 1948, 1949 [Kugel 513, UMBS; R.McV. 11082, MICH; E.G.V. 703, EGV]. "Trout Farm" 6 mi. S. of Pellston, 1952 [Hauke 40, UMBS].—Locally abundant, sandy banks above seepage areas, the "Gorge" near Biological Station, 1949 [R.McV. 10874, UMBS, MICH; E.G.V. 633, EGV].

Botrychium dissectum Spreng. E. C.

3.7 mi. due S. of Pleasantview (SW. corner, Sec. 5, Pleasantview Tp.), 1952 [W.H.W. 8063].—Second-growth woods, Levi Bur's farm near Riggsville Corners, 1952 [W.H.W. 8052].

Botrychium minganense Vict. E. C.

Numerous collections, mostly from woods or shaded grassy fields in both counties. See Wagner and Lord (1956) for a full discussion of this species and *B. lunaria* in the region.

Athyrium pycnocarpon (Spreng.) Tidestr. E.

Early reported (as *Asplenium angustifolium*) for the Petoskey region by Crozier (1885, p. 370) and perhaps by Clayberg (1920, p. 45—Bay View locality implied). Also on the Fallass and Swift manuscript list as rather rare but locally abundant at Bay View. The only old specimen found, however, is undated (ca. 1900): "Emmet Co. Mich. Walloon Lake" [Mary Freeman, MICH]. Moist depression in deciduous woods by Walloon Lake (Sec. 27, Resort Tp.), 1954 [E.G.V. 2396, UMBS, MICH, SMU, EGV].

Dryopteris ×*boottii* (Tuckerm.) Underw. (pro sp.) E. C.

Frequent in woods N. of Carp Lake-Sturgeon Bay road (SW. corner, Sec. 12, Bliss Tp.), 1952 [W.H.W. 8069]. Hardwoods near Crooked River at Alanson, 1955 [Rosa 66].—Wet woods (Reese's Bog) near N. shore of Burt Lake, 1949 [R.McV. 11023, UMBS, MICH; E.G.V. 708, EGV]. Rich woods near Colonial Pt. (Sec. 29, Burt Tp.), 1952, 1955 [W.H.W. 8048; Rosa 77]. Shaded edge of *Thuja* woods 3 mi. S. of Riggsville Corners, 1955 [Rosa 105].

[7] Genera and species are listed alphabetically in each family; sequence of families follows Gray's *Manual*, 8th ed.

Dryopteris clintoniana (D. C. Eat.) Dowell E. C.

Wagner's collections in the region have been previously cited by Hagenah (1955, p. 75): Rare in woods N. of Carp Lake–Sturgeon Bay road (S.W. corner, Sec. 12, Bliss Tp.), 1952 [W.H.W. 8068, BLH].—Large population in low woods ca. 200 yards from shore of Burt Lake on Mr. Barth's property near U.M.B.S. land, 1952, 1955 [W.H.W. 8049, BLH; Rosa 30]. Rich moist disturbed hardwoods, Sec. 20, Burt Tp., 1952 [Hauke 83, UMBS]. The hexaploid *D. clintoniana* is here treated as specifically distinct from its parents, the diploid *D. goldiana* and the tetraploid *D. cristata*.

Dryopteris ×*pittsfordensis* Slosson E.

One large plant of this hybrid (*D. intermedia* × *D. marginalis*) in cool shady woods at N. edge, Sec. 30, McKinley Tp., ca. 3.5 mi. NW. of Pellston, 1955 [W.H.W. 8226].

Dryopteris ×*slossonae* (Hahne) Wherry C.

Two plants of this hybrid (*D. cristata* × *D. marginalis*) near the parent species in rich woods near Colonial Pt. (Sec. 29, Burt Tp.), 1952, 1955 [W.H.W. 8046; Rosa 76].

Dryopteris cristata × *D. spinulosa* E. C.

Another hybrid at the same station as *D.* ×*pittsfordensis*, 1955 [W.H.W. 8225].—One large plant with parent species in shaded edge of *Thuja* woods 3 mi. S. of Riggsville Corners, 1955 [W.H.W. 8222; Rosa 103].

Typha angustifolia L. E. C.

Small wet shallow gravel pit between Pellston and Levering (Sec. 15, M Kinley Tp.), 1953 [Lord, UMBS; E.G.V. 1815, MICH].—Roadside ditch just inside eastern city limits of Cheboygan, along U. S. Highway 23, with *T. latifolia* and *T. latifolia* f. *ambigua*, 1953 [E.G.V. 1662, UMBS, MICH, EGV]. Also seen in ditches in Cheboygan. Probably not indigenous in this region, but spreading along roads, etc.; noticed as common in ditches along U. S. Highway 23 in Presque Isle Co.

Sparganium fluctuans (Morong) Robins. C.

Abundant in water to 30–50 cm. deep, Vincent Lake, 1949 [R.McV. 10782, UMBS, MICH].

Potamogeton crispus L. E.

In Little Traverse Bay, by city dock, Harbor Springs, 1952, 1953 [F. K. Sparrow, UMBS, MICH, EGV; E.U.C. 26087, UMBS].[8]

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[8] Tehon in 1929 mentioned that Oosting had collected this species in "Black Lake, Michigan"; the position of a dot on his distribution map (Torreya, 29:45) implies that this was assumed to be the Black Lake in Cheboygan and Presque Isle counties. Oosting himself, however, states (1932, p. 165) that his collections were all in Ottawa Co. An earlier collection of this species from under the dock at Harbor Springs has just been discovered in MICH [B. M. Robertson 861, Aug. 28, 1942].

Potamogeton illinoensis Morong E. C.

Previous records for *P. lucens* and *P. angustifolius* should be referred to *P. illinoensis*, the name now in use for American plants. *P. varians*, probably a hybrid of this species with *P. gramineus* [= *P.* ×*spathulaeformis* (Robbins) Morong (pro sp.)], was reported for Cheboygan Co. by Oosting (1932, p. 162).

Potamogeton longiligulatus Fern. C.

Two collections have been determined as this by Ogden, but with the observation that it may not be a valid species. Indian River, 1941 [Bedell, UMBS, MICH]. Black River, 1941 [Prescott, UMBS]. The Indian River collection is in flower (July 5); according to Ogden, the species has not been collected with mature fruit. Further study of *P. longiligulatus* is indicated.

Potamogeton richardsonii (Benn.) Rydb. E. C.

All previous records for *P. perfoliatus* in the region have apparently been based on specimens of *P. richardsonii*, which is a common and widespread species in the two counties. *P. perfoliatus* may, however, remain on the list on the basis of the following collection: Common in Black River 2–3 mi. upstream from junction with Cheboygan River, 1953 [E.G.V. 1775, UMBS, MICH, SMU, EGV].

Potamogeton vaginatus Turcz. E. C.

Referred here by Ogden is a collection from Nigger Creek near Topinabee, 1928 [J.H.E. 3655, MICH]. Compared with this material, and apparently the same species, is a 1953 Emmet Co. collection: Fairly common in Crooked River at Alanson to left of dock; associated with *P. pectinatus* [E.U.C. 26088, UMBS].

Recently discovered is another Emmet Co. collection of this species: Maple River 1.5 mi. E. of Brutus, 1941 [B. M. Robertson 552, MICH, UMBS]. The determination was verified by M. L. Fernald.

Zannichellia palustris L. var. *palustris* E.

"Goose Pond" and Big Stone Creek nearby, in Wilderness State Park. First found by F. K. Sparrow in 1942 [UMBS, MICH].

Alisma triviale Pursh C.

Almost all material from the region previously identified and reported as *A. subcordatum* is probably *A. triviale*. Both species apparently occur in the region.

Agrostis perennans (Walt.) Tuckerm. E.

Near Crooked Lake, 1899 [C.W.F., ALBC]. SE. of Petoskey, 1918 [C.W.F., ALBC]. In the manuscript list, Fallass noted that the species was rather rare in "open sandy woods."

Anthoxanthum odoratum L. E.

Waste ground, roadside near Conway, 1925 [C.W.F., ALBC].

Bromus pumpellianus Scr.bn. E. C.

Listed here in specific rank to call attention to it as the indigenous representative of *B. inermis*, but probably better considered as *B. inermis* subsp. *pumpellianus* (Scribn.) Wagnon, of which Wagnon recognizes two varieties: var. *arcticus* (Shear) Wagnon, found in Alaska, Yukon, and the Northwest Territory, is known in addition from a single Michigan collection. (Cf. Wagnon in Rhodora, 52: 211 [1950]; Brittonia, 7: 467 [1952].) This is not cited in full by Wagnon but is said to be from Little Traverse Bay. The only collection in MICH annotated by Wagnon as var. *villosissimus* (which he later considered the same as var. *arcticus*) is from sand dunes around little Traverse Bay, 1897 [C.W.F.]. A collection from sandy soil on the beach at Bay View, 1894 [C.W.F., ALBC] also appears to be this variety. Another collection of this rarity has recently been discovered in MICH [J. Schooley 580], from Lake Michigan shore ca. 1 mi. N. of Cross Village 1951.

Ranging from Colorado and the Black Hills northwestward to Alaska, with scattered stations in Ontario and Michigan about the Great Lakes, is var. *purpurascens* (Hook.) Wagnon, known from several collections in the Douglas Lake region. Shores of Little Traverse Bay, 1879 [C. F. Wheeler 143, MSU]. Sand dunes N. of Bay View, 1890 [C. F. Wheeler, MICH]. Abundant, inner margin of beach, in sand at edge of woods near Lake Michigan, ca. 1.5 mi. S. of Good Hart (Sec. 1, T. 36 N., R. 7 W.), 1948 [R.McV. 9707, UMBS, MICH]. Abundant, low dunes at edge of woods ca. 50 m. from Lake Michigan, Sturgeon Bay (Sec. 8, T. 38 N., R. 5 W.), 1948 [R.McV. 9712, MICH]. Lake shore, Temperance Point [Wilderness State Park], 1921 [J.H.E. 1662, UMBS, MICH, reported by Gates and Ehlers as *B. purgans*; annotated by Wagnon as probably a hybrid between *pumpellianus* and typical *inermis*].—Sandy beach at Mackinaw City, 1912 [C. K. Dodge, MICH]. The collections by Dodge and Wheeler in MICH originally determined as *pumpellianus* by Agnes Chase and later by Wagnon.

Bromus squarrosus L. E.

Abundant in cindery ballast, Pennsylvania R. R. near S. end of Round Lake, ca. 2 mi. SW. of Conway, 1954 [E.G.V. 2193, UMBS, MICH, SMU, EGV]. Previously known in Michigan from Kalamazoo Co. (Hanes and Hanes, p. 21).

Cynosurus cristatus L. E.

Wheeler (1899, p. 90) first published Fallass' discovery of this species at Bay View. "Moist bank at Bayview," 1894; "another bank, B. V.," 1897 [C.W.F., ALBC]. An 1897 sheet [C.W.F., MSU] is labeled "well established at Bay View."

Digitaria ischaemum (Schreb.) Muhl. E.

Lawn weed in Petoskey, 1917 [C.W.F., ALBC]. Dodge (1921, p. 22) implies that he saw the species at Mackinaw City.

Echinochloa pungens (Poir.) Rydb. E. C.

Frequent in cindery ground, Mackinaw City dump, 1953 [E.G.V. 1763, UMBS, MICH, EGV].—Roadside ditch toward Riggsville, 1915 [M. S. Pengally, as "*E.*

crusgalli," UMBS]. Locally frequent in mud of trail road to Grass Bay, ca. 5 mi. E. of Cheboygan, 1953 [E.G.V. 1762, UMBS, MICH, EGV].

Eragrostis spectabilis (Pursh) Steud. var. *sparsihirsuta* Farw. E.

Abundant along roadside of U. S. Highway 31 N. of Alanson, 1952 [E.G.V. 1394, UMBS, MICH, EGV]. Presumably adventive from southern Michigan; perhaps introduced in grass seed or straw.

Festuca saximontana Rydb. E. C.

All material on which the Gates and Ehlers report for *F. ovina* was based is *F. saximontana* (anthers 0.9–1.5 mm. long). True *F. ovina* (anthers 2.2–2.6 mm. long) is represented by one Emmet Co. collection: "Side of our garage, Petoskey," 1931 [C.W.F., ALBC].

Festuca rubra L. E.

A single tuft growing near brook E. o" Petoskey, 1899 [C.W.F., ALBC]. Bay View, 1916 [Swift, ALBC]. Abundant on hummocks, marly flats, Little Traverse Bay, 1949 [R.McV. 10784, UMBS, MICH].

Hordeum vulgare L. E.

Scarce (a single plant seen and collected) in cindery ballast, Pennsylvania R. R. near S. end of Round Lake, ca. 2 mi. SW. of Conway, 1954 [E.G.V. 2192, UMBS]. Field 3 mi. W. of Levering, 1951 [J. Schooley 573, MICH].

Muhlenbergia frondosa (Poir.) Fern. E.

Walloon Lake, 1913 [Clayberg, ALBC (C.W.F. Herb. No. 1999)]. The data on the label could apply as well to Charlevoix Co., in which much of Walloon Lake lies, but this collection (as "*M. sylvatica*") is credited to Emmet Co. on the Fallass and Swift manuscript list.

Muhlenbergia uniflora (Muhl.) Fern. C.

Abundant, wet sandy shore, E. side of Devereaux Lake (Sec. 29, Aloha Tp.), 1949 [R.McV. 11026, UMBS, MICH].

Oryzopsis racemosa (Sm.) Ricker E. C.

Roadside clay bank near Walloon Lake, 1917 [C.W.F., ALBC]. Occasional, deciduous woods ca. 3 mi. SE. of Conway, 1954 [E.G.V. 2356, UMBS, MICH, SMU]. Rather common, rich deciduous woods near N. shore of Walloon Lake, 1954 [E.G.V. 2392, UMBS; 2412, UMBS, EGV].—Burnt area, North Fishtail Bay, Douglas Lake, 1916 [F.C.G. 9553, as "*Brachyelytrum erectum*," UMBS].

Panicum flexile (Gatt.) Scribn. E. C.

Wilderness State Park, moist flood-shore, Lake Michigan, 1949 [W. G. Dore and R.McV. 10377, MSU].—A few plants on the gravelly shore of Lake Huron near the mouth of Mill Creek, Mackinaw Tp., 1941 [N. W. Katz 159, in his herb., *fide* N.W.K.].

Poa languida Hitchc. E.

Open sandy woods N. of Cross Village, 1927 [C.W.F., ALBC].

Polypogon monspeliensis (L.) Desf. E.

Waste heap from tannery on other side of Little Traverse Bay, Bay View, 1896 [C.W.F., ALBC, MSU]. On the manuscript list, Fallass noted this as very rare here.

Carex debilis Michx. var. *rudgei* Bailey E. C.

"Gorge" near the Biological Station, Cheboygan Co., 1948 [M. Feigley, UMBS]. Determination confirmed by F. J. Hermann, who reported (1951, p. 491) this species from Emmet Co. on the basis of a collection by Sr. Marcelline in the herbarium of Aquinas College.

Carex exilis Dew. C.

Reported by Hermann (1941, p. 18) from "edges of spruce islands, Little Lake Sixteen Bog, Cheboygan County, L. H. Harvey 699 (July 29, 1938)." Harvey's material has not been located, but I have found the species to be abundant on the bog mat at Lake 16 (ca. 8.5 mi. SE. of Cheboygan), 1953 [E.G.V. 1639, UMBS, MICH, SMU, EGV]. Determination confirmed by Hermann.

Carex hitchcockiana Dew. E.

Hastings Woods, Conway, 1919 [C.W.F., Mrs. C.W.F., and Mrs. Trask, ALBC]. An apparent duplicate in MICH, *ex herb.* A. J. Pieters, without indication of state or county ["Hastings Woods 1919. C. W. Fallass"] was, for lack of locality data, not cited by Hermann (1941), although he had confirmed the determination in 1938. This was the first station for this species north of Saginaw Bay in Michigan, and I was delighted to be able to rediscover Fallass' locality in 1953. The woods is a fine beech-maple-hemlock stand on the southwest side of Crooked Lake, and a large patch of *C. hitchcockiana* was found covering a hummock by a woods road [C.E.W. 8091, E.U.C., and E.G.V., UMBS; E.G.V. 1672, MICH, SMU, EGV]. Determination confirmed by Hermann.

Carex muhlenbergii Schkuhr C.

Hermann (1941, p. 8) included a dot in Cheboygan Co. on his distribution map of this species, and in 1952 he generously presented to the Biological Station herbarium the only sheet of the collection on which this record was based: Open aspen woods, Douglas Lake, 1928 [F.J.H. 1848, UMBS *ex herb.* FJH].

Carex rosea Schkuhr E.

The basis for the dot in Emmet Co. on Hermann's map (1941, p. 8) is a collection from Ramona, 1914 [C.W.F., MICH].

Carex tetanica Schkuhr E. C.

Round Lake region, 1916, and near Pellston, 1923.—Jack pine plains, 1912 [all three collections, C.W.F., ALBC, determined by F. J. Hermann]. Not previously known in Michigan north of Saginaw Bay except for one collection from Isle Royale.

Cyperus rivularis Kunth E.

Locally abundant in wet marshy sand by a small stream near its mouth on Little Traverse Bay, SE. ¼, Sec. 16, Little Traverse Tp., 1953 [E.G.V. 1812, UMBS, MICH, EGV]. Included by Swift on the Fallass and Swift list as rather rare at Bay View and Harbor Springs, but Fallass apparently never found it.[9]

Eleocharis calva Torr. E. C

C. W. Bazuin, of Grand Rapids, writes me that his No. 3802 from Cecil Bay was determined as *E. calva* by Svenson.—Wet sandy shore of Munro Lake, 1933 [J.H.E. 5528, UMBS]. Marshy pasture, Ingleside, 1936 [J.H.E. 6145, UMBS]. Swampy ground, S. shore of Burt Lake, 1936 [J.H.E. 6136, MICH].

Eleocharis elliptica Kunth E. C.

The only collection found in support of Gates and Ehlers' listing of *E. tenuis* is *E. elliptica* and came from East Point; there is also material in UMBS from Sedge Point (both localities on Douglas Lake, Cheboygan Co.). Other collections show the species to be common in the region: Mouth of Sucker Creek and Little Traverse Bay. —"Mud Lake" 6 mi. SE. of Cheboygan, and Silver Lake (Wilmot Tp.), etc.

Eleocharis intermedia (Muhl.) Schultes E. C.

Muddy banks of Sucker Creek, Sturgeon Bay, 1931 [J.H.E. 4890, UMBS]. Frequent in moist sand, drying beach pools on point at Cecil Bay, 1954 [E.G.V. 2553, UMBS, MICH, SMU].—Along Bessey Creek, 1941 [Myers 291, UMBS]. Forming small carpets on open soupy mud at Blanchard Bog ("Mud Lake," Sec. 21, Hebron Tp.), 1953 (E.G.V. 1700, UMBS, MICH, EGV].

Eleocharis quadrangulata (Michx.) R. & S. C.

Shallow water, NW. side of Black Lake, near Black Lake Hotel, 1948 [F. K. Sparrow 1075, UMBS, MICH].

Eleocharis robbinsii Oakes C.

In the deepest water (ca. 0.5 m.) of a *Calamagrostis* marsh ("Mud Lake," ca. 6 mi. SE. of Cheboygan), 1951 [E.G.V. 936, UMBS, EGV]. The material is immature, with no spike developed, but is referred to this species by the abundant capillary submersed leaves and the young culm, which is triangular in cross section.

Fimbristylis autumnalis (L.) R. & S. C.

Abundant, wet sandy shores, E. side of Devereaux Lake (Sec. 29, Aloha Tp.), 1949 [R.McV. 11025, UMBS, MICH].

Psilocarya scirpoides Torr. E.

This was perhaps the most valuable discovery, from a phytogeographic point of view, in the Fallass herbarium. A coastal plain disjunct, it was previously known in

[9] The Cheboygan County report by Gates (1913, p. 87) is based on material of *C. houghtonii*.

Michigan only from the southwestern quarter of the Lower Peninsula (Kent, Kalamazoo, and Muskegon Counties). Wet shore of Little Traverse Bay, near Paige [Sec. 16, Little Traverse Tp.], n.d. [C.W.F., ALBC]. A letter from H. T. Darlington (Oct. 5, 1917) attached to the sheet gives the determination for specimens which Fallass had sent him, but no material has been found at MSU. Fallass' copy of Gray's *Manual*, 7th ed., has a marginal note which fortunately supplies the year in which he found this species: "Paige, 1914." It was noted as very rare on the Fallass and Swift list. I have thoroughly searched the site without success in the recent years of comparatively high water levels. When the Great Lakes lower to a level similar to that of the 1910–1915 low period, it is to be hoped that this plant may be rediscovered.

Symplocarpus foetidus (L.) Nutt. C.

A single large plant (native ?) at edge of bog forest, Reese's Bog, about 150 ft. from Burt Lake at intersection of north-south road in Reese's Bog and small road paralleling Burt Lake, 1953 [C.E.W. 8253, UMBS]. The occurrence of only a single plant at this site is reason to question whether the species is really a part of our flora. It was on the Fallass and Swift manuscript list as common in Emmet Co. and seen by both authors, but there are no specimens in the Fallass herbarium. (It is difficult to imagine that this species could have been confused with anything else!) I have looked in vain for skunk cabbage in favorable sites for several years.

Wolffia columbiana Karst. C.

Cattail marsh with *Lemna* and *Spirodela*, Cheboygan Dump, Cheboygan, 1955 [W.H.W. 8208 and E. M. Gage, UMBS, MICH, EGV].

Luzula acuminata Raf. E.

Very common in mixed woods between road and bluff, Secs. 5–32, West Traverse Tp. (near Five Mile Creek on Lake Shore Cutoff Drive), May 2, 1953 [E.G.V. 1543, UMBS, MICH, BLH, SMU, EGV].

Allium cepa L. C.

Four stems (of which 3 were collected) from clump of bulbs in roadside ditch (not by any farmhouse or garden), SE. corner, Sec. 18, Hebron Tp., ca. 7 mi. S. of Mackinaw City, 1954 [E.G.V. 2498, UMBS, MICH, EGV]. A waif of uncertain origin here.

Allium cernuum Roth. E.

Walloon Lake, 1912 [Clayberg, ALBC (*ex herb.* C.W.F.)]. The locality could be in Charlevoix Co., in which a portion of Walloon Lake lies, but this record is included on the Fallass and Swift list for Emmet Co. with the added comment that it is rather rare. There are no data on which to judge whether the plant is indigenous this far north in the state.

Asparagus officinalis L. E. C.

A rather frequent waif along roadsides, often some distance from cultivated ground, more often seen than collected. Edge of woods and bramble thicket, Sec. 26,

Springvale Tp., 1951 [E.G.V. 929, EGV]. Occasional along gravel roadsides near Oden, 1952 [E.G.V. 1346, UMBS, MICH].—Overgrown yard back of cottage, N. shore of Burt Lake, 1928 [F. J. Hermann 1883, UMBS]. Noted on the Fallass and Swift list as a rather common escape along roadsides and fields.

Polygonatum pubescens (Willd.) Pursh E. C.

All previous records for *P. biflorum* in our area should be referred to this species, which is widespread in deciduous woods. *P. pubescens* was cited for Douglas Lake by Bush in 1927 (Am. Mid. Nat., 10: 387).

Trillium erectum L. E.

"From somewhere N of Conway, Emmet Co. . . . May 20, 1924"; 3 specimens (sheet 3942) in the Fallass herbarium [ALBC], collected by "a stranger." Fallass' annotation above the label says: "These plants were found and brought to me (so Joe [Seward, his clerk] says) as stated below." The flowers have deep red petals and ovaries; the filaments are about half the length of the anthers—some are 4 mm. long with 6-mm. anthers; the peduncles are not declined, although the plants were evidently somewhat wilted at the time of pressing. There is another specimen with erect peduncle, filaments 3 mm. and anthers 5 mm., with data: "Mrs. Oven of Petoskey has a few plants of *T. erectum* growing in her yard. #2 was one of them. She says they were brought to her from the near country by a woman . . ." A third collection is a fruiting plant from Round Lake, 1897 [C.W.F., ALBC], which I am unwilling to attempt to determine.

Iris pseudacorus L. E.

On sandy point near Conway on Crooked Lake (Sec. 24), 1953 [E.U.C. 26064, C.E.W., and E.G.V., UMBS]. A single large clump at edge of Crooked River, ca. 50 yards S. of public landing at Alanson, 1953 [C.E.W. 8140 and E.U.C., UMBS].

Habenaria flava (L.) R. Br. C.

Cited from Cheboygan Co. in Beal (1905, p. 64), on the authority of Beardslee and Kofoid. Wet places in pine plains, Black Lake, 1890 [C.A.K., MICH, OC]. Cheboygan Co., 1890 [H.C.B., OC]. Determination of material in OC confirmed by Schweinfurth; in MICH, by Correll.

Malaxis unifolia Michx. C.

A single plant on grassy hummock at edge of pastured *Acer saccharum* woods, farm of Levi Bur, Sec. 30, Inverness Tp., ca. 1.2 mi. S. of Riggsville Corners, 1953 [C.E.W. 8168, UMBS]. Locally frequent in an extensive patch of *Lycopodium clavatum* in dry open aspen-maple woodland on S. side of trail road S. of Mud Lake bog (Sec. 18, Inverness Tp.), 1955 [W.H.W. 8197, UMBS; E.G.V. 2705, MICH, SMU, EGV].

First reported for the region by Darlington (1921, p. 258) on authority of Swift, who had included it on the Fallass and Swift manuscript list on the basis of one specimen from wet woods near Bay View; the specimen was presumably not collected.

Orchis rotundifolia Pursh E.

Harbor Springs swamp, 1892, 1903 [Mary Freeman, MICH; C.W.F., ALBC]. Near Petoskey, 1893 [J. L. Stone, MICH]. The Stone and Fallass records were mentioned by Darlington (1921, p. 246). It was, incidentally, while collecting this species in a "sphagnum swamp" west of Harbor Springs that Swift first met Fallass in July of 1903 (Swift, *in litt.*).

Spiranthes tuberosa Raf. C.

Cited from Cheboygan Co. (as *S. grayi*) by Correll (1950, p. 204) on the basis of two collections: Jack pine plains at Indian River, Aug. 12, 1934 [F.C.G. 17764, KSC]. Jack pine association south of Burt Lake, Aug. 14, 1931 [F.C.G. 16641, UMBS *ex* KSC]. A considerable extension from the main range of this species.

Salix purpurea L. C.

Roadside, springy places on hillside between Secs. 25 and 26, Hebron Tp., ca. 9 mi. W. of Cheboygan, 1948 [R.McV. 9793, MICH].

Salix subsericea (Anderss.) Schneider *sensu* Ball E. C.

Specimens from our region previously reported as *S. sericea*, as well as later collections, have been referred to *S. subsericea* by C. R. Ball. This is a frequent willow throughout the region, first reported under the correct name by Walp (1935, p. 235).

Betula ×*sandbergii* Britt. (pro sp.) E. C.

The hybrid of *B. papyrifera* and *B. pumila* was first found at two localities by C. E. Wood: Low open ground near woods, center of E. edge of Sec. 1, Carp Lake Tp., ca. 4 mi. S. of Mackinaw City, 1954 [E.G.V. 1844, UMBS, MICH, SMU, EGV].—West side of Malone Lake, Sec. 11, Hebron Tp., ca. 7 mi. SE. of Mackinaw City, 1952 [E.G.V. 1405, EGV].

Quercus ellipsoidalis Hill C.

Material from the jack pine plains south of Burt Lake previously identified as *Q. velutina* seems better referred to *Q. ellipsoidalis* [J.H.E. 1230, UMBS, MICH] or to *Q.* ×*palaeolithicola* Trel. [C. O. Erlanson 438, UMBS, MICH], which is the hybrid of the two species. Characteristics of buds, leaves, and fruit do not fit typical *velutina*. These oaks are not uncommon on the jack pine plains but have seldom been collected—especially in fruit.

Quercus macrocarpa Michx. E. C.

Petoskey, Sept. 4, 1886 [A. A. Crozier, MSU]; there are no data to indicate whether the tree was indigenous, but it is perhaps doubtful whether any shade trees of this species were being planted in Petoskey as early as 1886, or that a visiting collector would bother to take specimens from one, if they were.—Reported by Beal (1905, p. 70) from Cheboygan Co., as found by Beardslee and Kofoid: Beach of Black Lake, 1890 [C.A.K., OC]. Evidently rediscovered at the same locality in 1955: Trees up to 25 ft. tall, colony along edge of Black Lake ca. ½ mi. SE. of Black Lake Hotel, near

mouth of Upper Black River [W.H.W. 8206, UMBS]. All three collections from the region are sterile but are easily placed by the nature of the lobing of the leaves and by their finely stellate-pubescent under surfaces. Noted by Dodge (1921, p. 38) north "to Mackinaw City, Cheboygan County."

Asarum canadense L. E.

One patch of 20–30 plants (not seen elsewhere), NW. corner, Sec. 5, West Traverse Tp., in beech-maple-hemlock woods on steep slopes above Lake Michigan, 1948 (R.McV. 9705, UMBS, MICH].

Polygonum achoreum Blake E. C.

Most of the collections from the region labeled as "*P. erectum*" are *P. achoreum*. Sandy newly made roadside ½ mi. W. of Bliss, 1953 [E.G.V. 1798, UMBS, EGV].—Dumping ground, Cheboygan, 1936 [J.H.E. 6189, UMBS, MICH]. Roadside, Inverness Tp., 1928 [J.H.E. 3746, UMBS, MICH]. Weedy soil at Black Lake Hotel, 1953 [C.E.W. 8265, UMBS, MICH].

Polygonum coccineum Muhl. E. C.

Several collections in UMBS labeled as "*P. amphibium*" are referred to this species, which is evidently not uncommon in the region. Goose pond in Wilderness State Park.—Bessey Creek, Blanchard Lake, Douglas Lake, etc. Early reported from Cheboygan Co. in Beal (1905, p. 72, as *P. emersum*). J.H.E. 234, from shore of Douglas Lake, cited by Stanford in 1925 (Rhodora, 27:164).

Rumex altissimus Wood C.

An immature collection from wet deciduous woods ca. 4 mi. S. of Wolverine (W. ½ of SE. ¼, Sec. 25, Wilmot Tp.), 1955 [E.G.V. 2710, UMBS] appears to be this species, which was definitely cited for the county from Bryant's [F.C.G. 10533, F] by Rechinger in 1937 (Field Mus. Nat. Hist. Bot. Ser., 17: 47).

Chenopodium leptophyllum Nutt. E.

Occasional in railroad ballast at Pellston, 1952 [E.G.V. 1356, UMBS, EGV; 1387, UMBS, MICH, EGV]. Presumably adventive from farther south or west.

Cycloloma atriplicifolium (Spreng.) Coult. E.

Frequent in railroad ballast with the preceding, and similarly adventive, 1952 [E.G.V. 1354, MICH; 1381, UMBS, MICH, EGV].

Amaranthus powellii S. Wats. C.

Camp Davis [Biol. Sta.], 1928 [Coburn and Dean, as "*A. retroflexus* (form bushy)," UMBS]. Determined by J. D. Sauer.

Mirabilis hirsuta (Pursh) MacM. E.

Frequent in railroad ballast in the vicinity of Pellston and Levering (and between), where less common than *M. nyctaginea*. First noted here by McVaugh in 1949. [E.G.V. 624b, EGV; 1386, UMBS, EGV].

Cerastium arvense L. E.

Roadside by parking lot, Waugoshance Point, Wilderness State Park, 1953 [E.G.V. 1591, UMBS, EGV]. The plant does not appear indigenous at this site.

Dianthus armeria L. E. C.

Cross Village hardwoods, 1948 [A. Kugel 680, UMBS]. Sandy soil in the aspens near Cross Village, 1950 [E.G.V. 817, EGV].—Crossroads 2 mi. S. of Riggsville, 1951 [E.G.V. 1001, UMBS].

Dianthus plumarius L. C.

Old grassy field on the jack pine plains, 1923 [C.W.F., ALBC].

Gypsophila acutifolia Fisch. C.

Locally common, weedy roadside across from dilapidated (but occupied) farm, ca. 3 mi. E. of Wolverine, 1955 [E.G.V. 2741, UMBS, MICH, SMU, EGV]. Also seen running wild in farmyard, whence undoubtedly escaped and well established.

Silene armeria L. C.

A single depauperate specimen (15 cm. tall, with 5 fls.) by a long-abandoned railroad grade at E. end of N. edge of Sec. 16, Wilmot Tp., ca. 3.5 mi. SW. of Wolverine, 1951 [E.G.V. 951, EGV]. Locally common in sandy soil, waste ground by edge of woods back of faculty parking area, Biological Station, 1955 [E.G.V. 2707 and W.H.W., UMBS, MICH, SMU, EGV].

Silene cserei Baumg. E.

Railroad ballast 1.5 mi. S. of Levering, 1953 [C.E.W. 8187, UMBS, MICH, and E.G.V. 1681, EGV]. Apparently the first record for the state of Michigan.

Tunica saxifraga (L.) Scop. E.

Mackinaw City in sand along roadside near Fort Michilimackinac, 1947 [C. W. Bazuin 7431, MSU]. Previously reported for the state as an escape at Niles by Beal in 1908 (Mich. Acad. Sci., Rep., 10:89).

Nuphar ×*rubrodiscum* Morong C.

Hook Point, N. Fishtail Bay, Douglas Lake, Aug. 10, 1952 [F. K. Sparrow, UMBS, MICH]. One parent of the supposed hybrid, *N. microphyllum*, is not known in the region, but the other, *N. variegatum*, of which this resembles a small extreme, is common in Douglas Lake. The material in MICH has been confirmed by E. O. Beal in 1954 (as *N. luteum* subsp. *pumilum* × subsp. *variegatum*).

Nuphar variegatum Engelm. E. C.

This name should be applied to all material previously reported from the region as "*N. advena*."

Sanguinaria canadensis L. E.

Locally abundant, second-growth deciduous forest, low hills above lake bluffs, Sec. 1, Friendship Tp., ca. 1.5 mi. S. of Good Hart, 1948 [R.McV. 9277, UMBS,

MICH]. "Hastings Woods," Sec. 19, Springvale Tp., on SW. side of Crooked Lake [F.C.G. 22548, in 1953, UMBS; E.G.V. 1843, just past flowering, May 15, 1954, UMBS, EGV]. Noted as common in rich woods by Fallass and Swift, but no specimens support their record.

Dentaria laciniata Muhl. E.

Three small colonies, none of them flowering, in beech-maple woods, SE. ¼, Sec. 26, Friendship Tp., ca. 3.5 mi. N. of Harbor Springs, May 2, 1953 [E.G.V. 1542, UMBS, MICH, EGV]. Discovered here by H. W. Vogelmann. Noted as common in rich woods by Fallass and Swift, but as with the preceding species there are no specimens.

Descurainia pinnata (Walt.) Britt. var. *brachycarpa* (Richards.) Fern. E. C.

The material reported by Gates and Ehlers as "*Sophia incisa*" [= *D. richardsonii*] is actually this species. Several Emmet Co. collections by C.W.F. [ALBC] support the report by Walpole (1927, p. 326).

Lepidium densiflorum Schrad. E. C.

This is the common *Lepidium* in the region, and all material in UMBS and MICH previously identified as *L. virginicum* should be referred here. Although listed by Gates (1913, p. 93), this species was not included on the Gates and Ehlers list. *L. virginicum* may still be considered a part of the regional flora, however, on the basis of two collections from Emmet Co.: Roadside, Petoskey, 1926 [C.W.F., ALBC]. Locally common in waste ground, Mackinaw City dump, 1954 [E.G.V. 2181, UMBS, MICH, SMU, EGV].

Lunaria annua L. E.

Thicket on side of bluff leading down to Lake Michigan, not far from the old mission at Cross Village, 1916 [C.W.F., ALBC]. Originally determined as "*L. rediviva*" and reported by Walpole (1927, pp. 342–343) as such, but referred here by the sessile upper leaves of the flowering specimen.

Drosera linearis × *D. rotundifolia* E. C.

A thorough discussion of this hybrid in northern Michigan has been given by Wood (1955). Marly flats behind dunes along Sturgeon Bay, 1953 [C.E.W. 8122, UMBS, GH].—Duncan Bay, 1955 [W.H.W. 8221].

Mitella diphylla L. E.

Common to abundant in mixed woods on the bluff at the old Lake Nipissing shore west of Mackinaw City, especially in the vicinity of McGulpin Point, 1945, 1948 [E.G.V. 12 and 420, EGV; R.McV. 9426, UMBS, MICH]. Locally very abundant in ravines, mature beech-maple forest, steep sandy bluff above Lake Michigan, ca. 1.5 mi. S. of Good Hart, 1948 [R.McV. 9056, UMBS, MICH]. Previously reported by Voss (1949, p. 79). Listed as common in woods by Fallass and Swift, but they apparently did not collect it.

Agrimonia striata Michx. E. C.

Near Round Lake, 1923 [C.W.F., ALBC]. Hardwoods 2 mi. W. of Petoskey, 1924 [C. O. Erlanson 421A, MICH].—Roadside near Burt Lake, 1917, 1923 [J.H.E. 558 and 2731, MICH]. Roadside near Munro Lake, 1916 [J.H.E., UMBS].

Amelanchier interior Nielsen E. C.

Several collections are placed here by McVaugh: Abundant, sparsely forested sand dunes N. of Wycamp Lake, 1948 [R.McV. 9057, UMBS, MICH, BLH].—Shore of Douglas Lake, 1912 [Robertson, UMBS]. Sand ridge, E. side of Smith's Bog, 1924 [J.H.E. 2838 and 2841, determined as "*A. bartramiana* × *A. laevis* ?" by Wiegand, UMBS, MICH]. Also apparently this species, although the habitat is unusual, is a collection from edge of bog mat at Galloway Lake, ca. 1 mi. N. of Levering, Emmet Co., 1953 [E.G.V. 1629, MICH, EGV].

Crataegus brainerdii Sarg. E.

Sandy roadside W. of Harbor Springs, 1923 [C.W.F., as "*C. douglassii*," ALBC; J.H.E. 2630, MICH]. Top of bluff W. of Harbor Springs, 1927 [C.W.F., as "*C. chrysocarpa*," ALBC].—Sterile material from Colonial Point, 1920 [J.H.E. 1145, UMBS, MSU] may be this species but is insufficient for positive determination. According to E. J. Palmer, who has determined the material, we have both var. *egglestonii* (Sarg.) Robins. and var. *scabrida* (Sarg.) Egglest.

Crataegus brunetiana Sarg. var. *fernaldii* (Sarg.) Palmer E.

Roadside on the road to Cross Village, 1927, 1929 [C.W.F., as "*C. laurentiana*," ALBC]. Tree 20–25 ft., by roadside near Good Hart, 1928 [C.W.F., as "*C. lucorum*," ALBC]. Shrub about 4 m. tall along roadside (West Lake Shore Drive) W. of town, Mackinaw City, 1953 [E.G V. 1594 and 1707, UMBS, MICH, EGV]. All material determined by E. J. Palmer.

Crataegus chrysocarpa Ashe E. C.

No material has been found as a basis for the Gates and Ehlers report of a *Crataegus* "nearest *rotundifolia*" [= *C. chrysocarpa*]. It is apparently as common as any hawthorne in the region, however. Sandy woods near Round Lake, 1915 [Fuller, Swift, and C.W.F., as "*C. laurentiana*," ALBC]. Hillside in Harbor Springs, 1929 [C.W.F., ALBC]. Cross Village, 1947 [C. W. Bazuin 7437, MSU, BLH].—Jack pine plains [S. of Indian River], 1920, 1922, 1923, and n.d. [C.W.F., ALBC; C. O. Erlanson, MICH]. Palmer, who has checked all determinations, has placed most of our material in var. *phoenicia* Palmer.

Crataegus dodgei Ashe C.

Shrub in jack pine plains S. of Burt Lake, 1920, 1930, 1932, 1954 [J.H.E. 1231, MICH, MSU; F.C.G. 16416 and 17230, UMBS; E.G.V. 2543, MICH, EGV]. F.C.G. 16416 is the sole basis for his report of *C. lucorum* in the region. Precise locality data are lacking on the labels of Gates and Ehlers, but it is probable that their specimens

came from the same place as mine: SE. ¼, Sec. 3, Mentor Tp., at the only station for *Liatris cylindracea* in the region. All collections determined by E. J. Palmer.

Crataegus faxonii Sarg. E.

Open woods near Mackinaw City, 1922 [C.W.F., ALBC]. Fallass had labeled his specimen as "*C. chrysocarpa*," but the present determination has been confirmed by Palmer.

Crataegus levis Sarg. E.

Occasional at edge of old orchard by woods, W. edge, Sec. 11, Wawatam Tp., 2 mi. W. of town, Mackinaw City, 1953 [E.G.V. 1580 and 1709, UMBS, MICH, EGV]. Determined by Palmer.

Crataegus pedicellata Sarg. var. *albicans* (Ashe) Palmer E. C.

Mature beech-maple-hemlock forest, steep sandy bluffs above Lake Michigan, ca. 1.5 mi. S. of Good Hart, 1948 [R.McV. 9291, UMBS, MICH].—Maple Bay side of Colonial Point [Burt Lake], 1921 [J.H.E. 1746, MICH]. Occasional shrub, dry woods on hillside just SW. of Owens Fire Tower, ca. 6 mi. SE. of Alverno, 1954 [E.G.V. 2210, UMBS, MICH, EGV]. All material determined by Palmer.

Potentilla intermedia L. E.

Locally abundant with *P. argentea* along trail road through old field (grass and bracken) ca. 0.7 mi. E. of Pellston; first noted by David Crowe, 1955 [E.G.V. 2822, UMBS, MICH, BLH, SMU, EGV].

Pyrus ioensis (Wood) Bailey E.

Several trees 4–5 m. high, 5–8 cm. dbh, and numerous seedlings established, sandy soil on bluff overlooking Lake Michigan at "Indian Council Tree" (NW. corner, Sec. 8, Readmond Tp.), ca. 2 mi. SW. of Cross Village, 1948 [R.McV. 9711, UMBS, MICH]. The indigenous range of this species is usually considered to be west of Michigan, and it is possible that it is an escape from cultivation in our region. In fact, its occurrence near the Indian center of Cross Village makes it interesting to speculate whether possibly this had been in cultivation by the Indians.

Rosa ×*palustriformis* Rydb. (pro sp.) C.

R. michiganensis and *R. schuetteana* were both described by Erlanson from Douglas Lake and later considered as hybrids of *R. blanda* and *R. palustris*. As treated by Gleason (1952, ii: 323) and earlier suggested by Erlanson (1928, p. 110), *R. palustriformis* seems to represent the same parentage. As the oldest name, it has priority over the names of Erlanson. The only specimens found are Erlanson's, there being apparently no collections in support of Walp's record (1935, p. 239) of *R. palustriformis*.

Rosa spinosissima L. E. C.

An occasional escape from cultivation. Roadside, Wawatam Beach, east of Cecil Bay, 1916 [J.H.E. 226, UMBS, MICH; F.C.G. 9901, UMBS].—Probably escaped,

roadside by farm, W. edge, Sec. 18, Inverness Tp., 1953 [E.G.V. 1682, UMBS, MICH, EGV].

Rubus arundelanus Blanch.: "collective species" *sensu* Gleason E. C.

Some of the specimens from the region [e.g., C. O. Erlanson 266, mouth of Bessey Creek, Douglas Lake] previously labeled as *R. villosus* or *R. procumbens* [= *R. flagellaris* of current treatments] are apparently this collective species as defined by Gleason (1952, ii: 308–310). J.H.E. 3914 from Douglas Lake was cited by Bailey in 1943 (Gent. Herb., 5: 330) as *R. complex*, which is referred here by Gleason.

Rubus enslenii Tratt.: "collective species" *sensu* Gleason C.

Some specimens previously identified as *R. flagellaris* are possibly this collective species as defined by Gleason (1952, ii: 310). [Cf. J.H.E. 2310, Pine Point, Douglas Lake; C. O. Erlanson 228 and 344, Sedge Point, Douglas Lake.] Definitely referred here by Gleason is *R. michiganensis*, cited by Bailey in 1943 (Gent. Herb., 5: 368) from Douglas Lake. Most of the existing collections of *Rubus* from the region are too incomplete to use even the broad treatment of Gleason. This "collective species" and the preceding one are tentatively reported on the basis of material examined and the citations of Bailey. Needless to say, further collecting in this genus would be desirable.

Rubus orarius Blanch.: "collective species" *sensu* Gleason E.

The specimens from edge of woods at McGulpin Point, reported by Gates and Ehlers as *R. canadensis*, are this collective species of Gleason (1952, ii: 312). Also, sunny glade in aspen-birch-fir woods at N. end of French Lake, 1952 [E.G.V. 1183, EGV].

Sorbus decora (Sarg.) Schneid. E.

Small tree in mixed woods at edge of Nipissing Lake bluff W. of McGulpin Point, Wawatam Tp., 1948 [E.G.V. 419, EGV; R.McV. 9425, UMBS, MICH]. Tree in mixed woods, Sec. 8, Bliss Tp., 1948 [E.G.V. 486, MICH, EGV]. These stations previously described (Voss, 1949, p. 79).

Spiraea tomentosa L. C.

A few plants on sandy shores of E. and S. sides of Devereaux Lake (Sec. 29, Aloha Tp.), 1945, 1948 [E.G.V. 198, EGV; 508, UMBS, MICH]. (Reported in Voss, 1949, p. 79.) Plants were not noticed here in 1955.

Spiraea vanhouttei (Briot) Zab. E.

Several small shrubs established in sandy gravel on the steep slope of an abandoned quarry, W. edge of Petoskey, 1953 [E.G.V. 1673, UMBS, MICH, EGV].

Lathyrus sylvestris L. E. C.

Roadside of U. S. Highway 31 N. of Alanson, 1934 [J.H.E. 5583, as "*L. latifolius*," UMBS, MICH].—Twining on vegetation along dirt road ca. 4 mi. SE. of Cheboygan (near corner of Secs. 2, 3, 10, and 11, T. 37 N., R. 1 W.), 1951 [E.G.V. 959, UMBS, MICH, SMU, EGV].

Lotus corniculata L. [10] C.

One large clump in the aspens just S. of Pellston Road and W. of Topinabee Road, ca. ⅓ mi. S. of Douglas Lake, found by Paul Kilburn, 1954 [E.G.V. 2365, UMBS, MICH, EGV].

Vicia cracca L. E.

Along G. R. & I. [now Pennsylvania] R. R., S. of Petoskey, 1924 [C.W.F., ALBC]; labeled as "pink flowered race." A large patch at side of Highway M-131, Sec. 9, West Traverse Tp., 1952 [E.G.V. 1188, UMBS, MICH, SMU, EGV]. Locally abundant, grassy roadside, center of Sec. 25, Bear Creek Tp. [T35N], ca. 1 mi. S. of Conway, 1954 [E.G.V. 2349, UMBS, MICH, SMU].

Linum lewisii Pursh C.

A weed, presumably escaped from cultivation, becoming locally abundant on Biological Station grounds [E.G.V. 1634, UMBS, MICH, EGV].

Geranium molle L. E.

Reported by Beal (1905, p. 94) as found at Harbor Springs by "G. L. Maurice." The supporting specimen [MSU] was collected in 1903 by "J. L. Morice."[11] Included on later copies (but not the original) of the Fallass and Swift manuscript list, as found in a lawn in Bay View by Swift.

Geranium pusillum L. C.

A large plant branched from base, with other weeds by main road, Biological Station, 1955 [W.H.W. 8205 and E.G.V. 2747, UMBS, MICH, SMU, EGV].

Xanthoxylum americanum Mill. C.

A local high shrub or small tree in wet lowland woods beneath elm, ash, silver and red maple, etc., on W. side of Upper Black River, Sec. 34, T. 36 N., R. 1. E., ca. 8 mi. N. of Tower, 1951 [E.G.V. 1042 and C.E.W., UMBS, MICH, EGV].[12]

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[10] I am treating the name *Lotus* as feminine, as is usual for *Melilotus*, although the masculine gender has been widely used for the former. Both were masculine in classical Greek usage. Tournefort (Inst., 407 [1700]) treated *Melilotus* consistently as feminine when he took up the name, however, even though he indicated its Greek derivation. It was feminine in Latin, and so usually was *Lotus*, at least when applied to a legume. Linnaeus (Sp. Pl., 773–776 [1753]) treated the latter predominantly as feminine (including *L. corniculata*), although he was admittedly not consistent. (Tournefort [Inst., 402–404] was also divided on gender in *Lotus*.)

[11] Neither spelling seems to be correct. James L. Morrice, of Harbor Springs, represented Emmet County in the Michigan State Legislature for several years, from 1903–4 to 1909–10, and is presumably the collector here referred to.

[12] The only possible basis for the Cheboygan County dot in Billington's map (1949, p. 101) of the distribution of this species seems to be to consider it an error for Bois Blanc Island, Mackinac Co., from which it was reported by Dodge (1921, p. 52), since the other records by Dodge were obviously utilized by Billington.

Acer negundo L. C.

Reported by Gates and Ehlers as a planted tree, which is apparently reproducing to some extent along roadsides, railroads, and similar waste places. It seems worth while, however, to report a stand which appears indigenous: Trees to 4 or 5 m. tall, common with elm in flood-plain swamp forest on E. side of Sturgeon River at Wolverine, 1955 [E.G.V. 2811, UMBS, MICH, EGV].

Parthenocissus inserta (Kerner) Fritsch E. C.

All material reported from the region as *P. quinquefolia* should be referred to this species, which is frequent in thickets, especially in swamp forests and along streams.

Lechea intermedia Leggett C.

Moist sandy ground with young jack pines on SE. shore of Devereaux Lake (Sec. 29, Aloha Tp.), 1953, 1954 [C.E.W. 8264, UMBS; E.G.V. 2366, SMU, EGV].

Viola incognita Brainerd E. C.

A frequent violet in wet woods, bogs, and deciduous woods throughout the region. Most of the material labeled as *V. blanda* in UMBS has been placed here by N. H. Russell, as have a number of other collections.

Viola incognita × *V. pallens* C.

Pasture, W. shore of Burt Lake, Aug. 11, 1928 [J.H.E. 3757, UMBS]. Determined by N. H. Russell.

Viola incognita × *V. renifolia* E.

Common in wet *Thuja* swamp, edge of Secs. 22–23, Little Traverse Tp., N. of Round Lake, 1.5 mi. W. of Conway, May 20, 1954 [E.G.V. 1885A, UMBS, MICH, EGV]. Determined by N. H. Russell. It is of interest to note that in 1955 Russell (Am. Mid. Nat., 54: 481–494) cited both *V. incognita* and *V. renifolia* from Round Lake on the basis of specimens in Deam's herbarium collected by Fallass.

Viola lanceolata L. C.

Amid sedges in a dryish swale W. of Topinabee, Sec. 25, Burt Tp., 1949 [E.G.V. 738, EGV]. Wet, sandy ground on W. shore of marshy lake ("Mud Lake"), ca. 6 mi. SE. of Cheboygan, found by P. Dansereau, 1951 [E.G.V. 973, UMBS]. Locally abundant in shade of jack pines, moist sandy ground on SE. shore of Devereaux Lake (Sec. 29, Aloha Tp.), 1954 [K. Lems, May 23, in fl., UMBS; E.G.V. 2339, July 28, in fr., UMBS, MICH, SMU, EGV].

Viola rostrata Pursh E.

Frequent in deciduous woods near Mackinaw City (Wawatam Tp.): N. edge, Sec. 23, ca. 2 mi. SW. of town, 1949 [E.G.V. 576, EGV]; Sec. 11, ca. 1 mi. W. of town, 1949 [E.G.V. 577, EGV]; Sec. 10, ca. 2 mi. W. of town, 1950 [E.G.V. 781, UMBS, MICH, EGV]. N. of Cross Village, and open woods on road to Charlevoix [C.W.F., ALBC]. Occasional in beech-maple-hemlock woods, Sec. 31, West Traverse Tp., ca. 5.5 mi. NW. of Harbor Springs, 1952 [E.G.V. 1146, UMBS, MICH, SMU, EGV].

Viola selkirkii Pursh E. C.

Evidently a fairly frequent violet in deciduous woods in the region. Edge of woods E. of Petoskey, 1899 [C.W.F., ALBC]. Locally common in ravine in grazed deciduous woods near W. edge, Sec. 31, Maple River Tp., ca. 3.5 mi. SW. of Brutus, 1954 [E.G.V. 1838, UMBS, MICH, SMU, EGV]. Moist parts of deciduous woods, center of Sec. 30, Bear Creek Tp., ca. 4 mi. S. of Petoskey, 1954 [E.G.V. 1870, UMBS]. (All preceding collections flowering, May 9–20.)—On a large rotting log in the beech-maple forest of Riggsville Corners, 1929 [F.C.G. 15862, the basis of the Gates and Ehlers report of *V. hirsutula*, UMBS; determination as *V. selkirkii* confirmed by N. H. Russell].

Epilobium hirsutum L. E. C.

Muddy roadside ditch at edge of woods, SW. corner of Etherington and Askins Sts., W. of town, Mackinaw City, 1954 [E.G.V. 2401, UMBS, MICH, BLH, SMU, EGV].—Locally abundant at edge of thicket and adjacent field near dock of the cutter *Mackinaw* just SE. of mouth of Cheboygan River, 1953 [E.U.C. 26151 and H. Smith, UMBS; E.G.V. 1768, EGV].

Epilobium palustre L. var. *oliganthum* (Michx.) Fern. E.

Occasional and local in sphagnum amid low bog shrubs, mat at Galloway Lake, ca. 1 mi. N. of Levering, 1955 [E.G.V. 2704, UMBS, MICH, SMU, EGV].

Oenothera nuttallii Sweet E.

One patch along the railroad opposite Pellston airport, 1951 [C.E.W., UMBS, MICH; E.G.V. 1032, EGV].

Angelica atropurpurea L. E.

Bay View, 1894 [C.W.F., ALBC]. Along grassy road and in openings in mixed coniferous and deciduous woods at Wiener Lake (Sec. 32, West Traverse Tp.), ca. 4.5 mi. NW. of Harbor Springs, 1950 [C.E.W., UMBS]. Noted by Fallass as rather rare in waste places on the Fallass and Swift manuscript list.

Hydrocotyle americana L. E. C.

Abundant in cool shady woods along small stream just S. of road 3 mi. W. of U. S. Highway 31, N. edge, Sec. 30, McKinley Tp., 1955 [W.H.W. 8224 and H. Robinson, UMBS].—Locally frequent in wet mossy bog woods along edge of Beavertail Creek, ca. 0.5 mi. NE. of North Fishtail Bay, Douglas Lake, 1955 [E.G.V. 2774, UMBS, MICH, BLH, SMU, EGV]. Specimens have not been found to support the Fallass and Swift listing quoted by Kenoyer (1924a, p. 154), or the report by Coulter (1904, pp. 42 and 66) from Walloon River [Bear Creek] near Petoskey.

Levisticum officinale W. D. J. Koch E.

Locally abundant in sandy soil, dooryard of abandoned house, Middle Village, 1948 [R.McV. 9708, UMBS, MICH]. "A large stand . . . near the west end of Mullet Lake" was observed by Farwell from the train on his 1925 vacation (Am. Mid. Nat., 10: 22 [1926]).

Vaccinium corymbosum L. E. C.

Roadside near Brutus "found growing in water on the margin of swamp along with *Kalmia polifolia, Chamaedaphne calyculata . . .*," 1916 [C.W.F., ALBC].—Shrub at margin of fosse N. of cottage on E. shore of Lake 16 (Sec. 16, T. 37 N., R. 1. E.), ca. 8.5 mi. SE. of Cheboygan, 1953 [E.G.V. 1637 and F.C.G. 22532, UMBS, MICH, EGV].

Vaccinium vacillans Torr. E.

Tentatively added to the list on the basis of a young specimen which is apparently correctly determined: Emmet Beach [W. of Harbor Springs], May 20, 1899 [C.W.F., ALBC; evidently the basis of the report by Kenoyer, 1924b, p. 188]. No material has been found to support the record of Gates (1913, p. 98), also quoted by Kenoyer.

Phlox subulata L. E.

Two collections from colonies which have apparently spread to some extent from cultivation: From an old cemetery at Cross Village, 1916 [C.W.F., ALBC]; Fallass was more explicit on the manuscript list: "Escaped at Cross Village." A large patch in open thicket at edge of an old orchard, center of N. edge, Sec. 16, Bliss Tp., 1955 [E.G.V. 2622, UMBS, MICH, SMU, EGV].

Myosotis arvensis (L.) Hill E.

Local at disturbed edge of trail road through mixed woods, W. end, Sec. 11, ca. 2 mi. W. of town, Mackinaw City, 1953 [E.G.V. 1819, UMBS, MICH, EGV].

Myosotis laxa Lehm. E.

North shore of Crooked Lake at Conway, 1918 [C.W.F., ALBC]. Sunny glade in *Thuja* bog, W. edge, Sec. 23, ca. 1.5 mi. W. of Conway, 1953 [E.G.V. 1613, UMBS, MICH, EGV].

Myosotis sylvatica Hoffm. E.

Center grassy strip in trail road through mixed woods, Sec. 11, ca. 2 mi. W. of town, Mackinaw City, 1953 [E.G.V. 1577, UMBS, MICH, EGV]. (Not the same station as *M. arvensis*.)

Verbena simplex Lehm. E.

Open sandy field just north of Old Brewery on road to Harbor Springs, 1931 [C.W.F., ALBC]. Search for this species here in 1954 was unsuccessful.

Hyssopus officinalis L. E.

Well established as a shrub along clay banks on East Mitchell St., Petoskey, 1918 [C.W.F., ALBC].

Lycopus asper Greene C.

Common in wet ground along edge of fill by bridge across bay of Mullett Lake, Sec. 9, Koehler Tp., ca. 4 mi. NE. of Indian River, 1954 [E.G.V. 2325, UMBS, MICH,

EGV]. Perhaps not indigenous here; Michigan is apparently the eastern limit of native range.

Monarda punctata L. var. *villicaulis* (Pennell) Shinners E.

A few colonies near the railroad tracks at Pellston, presumably adventive from farther south in the state, 1949, 1952 [E.G.V. 747, EGV; Diez 62, UMBS]; first noted here by McVaugh in 1949. Although there are no specimens in ALBC, Fallass included this on the manuscript list as found in dry soil, railroad east of Petoskey, so it was evidently adventive at least as early as 1918.

Pycnanthemum tenuifolium Schrad. C.

One small patch of 5 plants at edge of a natural thicket on abandoned Mackinaw City golf course, 1951 [E.G.V. 1058, UMBS, MICH, EGV]. Previously known in the state only from the southern portion of the Lower Peninsula.

Salvia officinalis L. E.

The material cited by Gates and Ehlers as *S. nemorosa* should be referred to this species.

Hyoscyamus niger L. E.

Near Petoskey, 1895 [C.W.F., ALBC]. Long known as a weed on Mackinac Island (Mackinac Co.), and reported by Swift on the Fallass and Swift list from Mackinaw City.

Physalis subglabrata Mack. & Bush C.

The collection of *Physalis* listed by Gates and Ehlers without specific determination has been placed here by McVaugh. Noted by Fallass on the manuscript list as not common at Bay View, 1897.

Solanum rostratum Dunal C.

Barnyard, farm of E. A. Riggs, Sec. 12, Burt Tp., 1940 [UMBS, no collector].

Cymbalaria muralis Gaertn., Mey., & Scherb. E.

Wet shore of Little Traverse Bay near Kegomic, 1923 [C.W.F., ALBC].

Linaria dalmatica (L.) Mill. C.

Roadside, U. S. Highway 27 N. of Indian River, where first noted by McVaugh in 1949 [R.McV. 11072, MICH; E.G.V. 751, EGV; 1649, UMBS].

Penstemon hirsutus (L.) Willd. E.

Weedy area between U. S. Highway 31 and railroad, opposite airport at Pellston, 1951 [E.G.V. 917, UMBS, EGV]. Also seen along railroad at Mackinaw City. Undoubtedly adventive from farther south in the state; Pennell (1935, p. 241) held a record from Mackinac Island for further confirmation before considering the species indigenous so far north. (Also found at Mackinac Island by Hicks [Beal, 1905, p.

119].) Included by Swift on the manuscript list as very rare, on dry hillside near Bay View.

Scrophularia marilandica L. E.

Cited from Petoskey by Pennell (1935, p. 288), collected by A. A. Crozier. Professor C. A. Taylor of South Dakota State College, in the herbarium of which the specimen is located, kindly lent me the sheet (No. 7568). The only additional information is the date: Sept. 4, 1886. Swift reported this species as common in fields on the manuscript list, but as the other common species, *S. lanceolata*, was not listed, his identification may be questioned.

Veronica beccabunga L. E.

Tannery Creek where it empties into Little Traverse Bay, 1924 [C.W.F., ALBC]. Fallass' comment on the sheet reads: "Its location '. . . is possibly due to the seed having been washed in from Lake Michigan, but more likely to having been brought to the Tannery with hides."

Veronica chamaedrys L. E.

Growing in grass, railroad between Petoskey and Bay View, 1917 [C.W.F., ALBC].

Veronica catenata Pennell E. C.

All the material from the region previously determined as *V. anagallis-aquatica* should be referred to this species (called *V. comosa* in Fernald, 1950, and *V. salina* in Gleason, 1952; cf. Burnett in Watsonia, 1: 349–353 [1950] for discussion of the nomenclature).

Veronica longifolia L. E.

Two collections as a waif or escape, the first with better claim as a basis for admission to the list: Marshy roadside just S. of Oden, Crooked Lake, 1946 [W. C. Steere, UMBS]. Clump of several stems in tall grass on an old rubbish heap, Mackinaw City dump, 1953 [E.G.V. 1766, UMBS, MICH, EGV].

Utricularia gibba L. C.

Little Lake 16, ca. 8.5 mi. SE. of Cheboygan, 1947 [H. Iltis 2959, UMBS]. Grass Bay, E. of Cheboygan, 1953 [C.E.W. 8272, UMBS, MICH]. F. K. Sparrow reports seeing this species at Marl Bay, on Douglas Lake.

Utricularia minor L. E. C.

O'Neal Lake, 1941 [H. Phinney, UMBS]. Beach pool near Cecil Bay, 1925 [J.H.E. 3285, mostly *U. intermedia*, UMBS]. Crooked River at Alanson, 1951 [C.E.W., UMBS]. Frequent in shallow, drying beach pools on NE. side of the point at Cecil Bay, 1954 [E.G.V. 2554, UMBS].—Locally frequent in mud of animal trail on bog mat at Blanchard Lake ("Mud Lake"), Sec. 21, Hebron Tp., 1953 [E.G.V. 1698 and C.E.W., UMBS, MICH, BLH, EGV]. Grass Bay, 1953 [C.E.W. 8270, UMBS]. Locally common in shallow water among tussocks of sedges, marsh by plank bridge

over Elliott's Creek, Sec. 35, T. 36 N., R. 1 W., ca. 4 mi. E. of Cheboygan, 1954 [E.G.V. 2179, UMBS, MICH, SMU, EGV]. Evidently a common species in the region; perhaps overlooked before because it is frequently found with the larger *U. intermedia.*

Galium sylvaticum L. E.

Bay View, 1921 [R. Ford 1088, BLH, ALBC]. (Specimen in BLH is *ex herb.* Branson A. Walpole; the specimen *ex herb.* Fallass in ALBC gives Walpole as collector, without number.)

Galium verum L. E.

The collection cited in Gates and Ehlers as *G. wirtgenii* is this species.

Lonicera ×*bella* Zab. (?) E.

The material cited by Gates and Ehlers as *L. morrowii* has the leaves and petioles too glabrous to be that species; it is probably *L.* ×*bella* (*ex char.*). Material which corresponds better to descriptions of *L. morrowii* is from several shrubs in a deciduous woods evidently once used as a dump, western edge of Petoskey, 1953 [E.G.V. 1674, UMBS, MICH, EGV].

Campanula medium L. E.

Several plants established along disturbed roadside by vacant lots in Mackinaw City (Central Ave., W. of town), 1954 (seen again in 1955) [E.G.V. 2182, UMBS, EGV].

Lobelia inflata L. E. C.

Roadside W. of Petoskey, near Walloon Lake, 1918 [C.W.F., ALBC].—Road to Smith's Bog near Biological Station, 1952 [L. H. Shinners, SMU].

Antennaria fallax Greene C.

Locally frequent at edge of woods along U. S. Highway 23 just S. of Grass Bay, ca. 4.5 mi. E. of Cheboygan, May 23, 1954 [E.G.V. 1978, UMBS, MICH, SMU, EGV].

Anthemis tinctoria L. E. C.

Margin of Little Traverse Bay at the foot of the big washout W. of Petoskey, 1922 [C.W.F., ALBC].—Sandy shore of SW. end of Fairy Island, Douglas Lake; 2 plants only, 1950 [G. Kikudome 63, UMBS]. Previously noted as an escape in Michigan by Farwell, who found it in the vicinity of Calumet in 1937 (Gray Mem. Bot. Assn., Bull., 5(1): 9 [1937]).

Artemisia pontica L. C.

The material on which Gates and Ehlers based their report of *Anthemis arvensis* is actually *Artemisia pontica.*

Aster dumosus L. var. *strictior* T. & G. E.

Bay View, Sept. 11, 1878 [D. Clarke 4973, MSU]. Determination confirmed by L. H. Shinners. Since Clarke's field work was mostly in the vicinity of Flint, Mich-

igan, this range extension might be questioned; however, the record is credited to Clarke (for "Petoskey") in the floras of Wheeler and Smith (1881), Beal and Wheeler (1892), and Beal (1905)—it was evidently accepted by contemporary botanists. Material in support of Beardslee's report for Cheboygan Co. (Beal, 1905, p. 130) has not been found.

Aster lucidulus (Gray) Wieg. E. C.

This entity seems sufficiently distinct from *A. puniceus* to warrant recognition as a good species, as it has been treated by Wiegand, Deam, Shinners, and Cronquist. It is an abundant aster in moist places, especially ditches at the edges of woods, throughout the two counties. True *A. puniceus* is relatively scarce, differing most conspicuously in its fewer flowered, more open inflorescence, and more sparsely leafy stem, which is more coarsely hairy.

Aster pilosus Willd. var. *pringlei* (Gray) Blake E. C.

Almost all the material labeled by Gates and Ehlers as *A. junceus* is this species (determined by L. H. Shinners) rather than *A. junciformis*. *A. pilosus* is common in both counties in wet places, especially ditches and lake shores. One collection from the highway near Mill Creek, 1941 [Myers 261, UMBS] has been determined by Shinners as *A. laevis* × *A. pilosus* var. *pringlei*.

A. junciformis may remain on the regional list on the basis of the following collections: Sphagnum swamp N. of Harbor Springs, 1915 [Swift and C.W.F., ALBC]. Occasional in sphagnum among shrubs at edge of bog mat, Galloway Lake, ca. 1 mi. N. of Levering, 1953 [E.G.V. 1816, UMBS, MICH, SMU, EGV; determined by Shinners].—Bog mat at Brown Lake, 1942 [F.C.G. 21454, UMBS; determined by Shinners].

Centaurea diffusa Lam. E. C.

A weed rapidly spreading in the region, first collected in 1948 7 mi. W. of Levering [R.McV. 9496, UMBS, MICH] and S. edge, Sec. 11, Little Traverse Tp. [E.G.V. 491, MICH, EGV]. It has become common at many places in both counties and is evidently freely hybridizing with *C. maculosa* (which was first collected in the region in 1927 and is now abundant along roadsides throughout).

Echinacea angustifolia DC. E.

Railroad tracks between Pellston and Levering, 1920 [J.H.E. 1010, UMBS]. A waif not since found.

Eupatorium rugosum Houtt. E.

Along Wycamp Road to Cross Village, 1949 [F.C.G. 22122, UMBS]. Gates' label reads "Herb escapt from cultivation . . ." and the specimen was identified only to genus. The road to Wycamp Lake is lacking in gardens or dwellings, and there seems to be little reason not to consider the species as indigenous except that it is farther north in the state than usual. Noted as common at borders of woods by Fallass and Swift, but like so many species on their manuscript list, apparently not collected by them.

Filago arvensis L. E. C.

First reported for the region (and for the Gray's *Manual* range) by Shinners in 1953 (Rhodora, 55: 228) on the basis of his No. 13536 collected along roadside ¼ mi. E. of Pellston, 1952 [MICH, SMU].—Since found in Cheboygan Co.: Occasional in sandy roadside ditch, Sec. 19, Inverness Tp., just E. of Riggsville Corners, 1953 [E.G.V. 1769 and C.E.W., UMBS, MICH, SMU, EGV]. Scattered but locally frequent in loose sandy soil, clearing in aspen woods where pipeline was laid in 1953, 0.2 mi. N. of Pellston-Cheboygan road, ca. 2 mi. NE. of Biological Station, 1955 [E.G.V. 2721, UMBS, EGV]. Previously known in the United States and Canada from northern Idaho, southern British Columbia, and western Montana (cf. Cronquist in Ray J. Davis, Flora of Idaho, 1952).

Galinsoga ciliata (Raf.) Blake E.

Weed in a flower bed in park, Petoskey, 1922 [C.W.F., ALBC].

Helianthus divaricatus L. C.

"Norway Pine woods at Red Pine Point, Mullet Lake," 1936 [F.C.G. 19401, UMBS]. Determination confirmed by Shinners.

Helianthus giganteus L. C.

The 1933 collection from Cheboygan dumping ground reported by Gates and Ehlers as *H. hirsutus* has been determined as *H. giganteus* by Robert W. Long.

Helianthus strumosus L. C.

A single large clump (presumably adventive from southern Michigan) along dry roadside through mixed woods, NW. corner, Sec. 12, Maple Grove Tp., ca. 6.5 mi. S. of Tower, 1955 [E.G.V. 2784, UMBS, MICH, EGV]. Determined as depauperate material of this species by Long.

Hieracium florentinum All. E. C.

Now an abundant weed throughout the region, having spread very rapidly in recent years. The earliest collection from the region seems to be from an open grassy field in Mackinaw City, June 30, 1935 [H. A. Gleason, UMBS *ex herb.* H.A.G., Jr.].

Lactuca hirsuta Muhl. var. *sanguinea* (Bigel.) Fern. E.

Sand banks, Bay View and Wequetonsing [C. F. Wheeler in 1890, MSU; S. H. Camp 23 in 1894, MSU; C.W.F. in 1894 and 1897, ALBC, MSU].

Lapsana communis L. E.

Open sandy woods, Harbor Point, 1923 [C.W.F. with Mrs. C.W.F. and Ed Baxter, ALBC]. Harbor Point, 1924 [C.W.F. and R. Strong, ALBC].

Liatris novae-angliae (Lunell) Shinners var. *nieuwlandii* (Lunell) Shinners C.

An apparent waif, railroad north of Topinabee, 1934 [J. M. Calwell, UMBS]. Determined by L. H. Shinners. There are no specimens to support the record of

Dodge (1921, p. 68, as "*L. scariosa*") for Cheboygan County as an indigenous species, although it is common on oak and jack pine plains a short distance south in the state.

Ratibida columnifera (Nutt.) Wooton & Standl. E.

Railroad tracks near Round Lake, 1945 [J. M. Kryn, UMBS]. Another waif, not since found. According to Shinners (Rhodora, 57: 293 [1955]) the name of this plant should be *R. columnaris* (Pursh) Raf.

Senecio congestus (R. Br.) DC., var. *palustris* (L.) Fern. E.

Shore of Lake Michigan at 9 Mile Point [ca. 8 mi. NW. of Harbor Springs], July 5, 1934 [Swift, ALBC]. Apparently the first record for the state of Michigan, this is the last entry in Fallass' own copy of the manuscript list, in which he noted additions. The collection seems to be the last Michigan material added to his herbarium.

Senecio vulgaris L. C.

Waste ground at edge of field by Nelson's Greenhouse, Cheboygan, 1953 [E.G.V. 1745 and C.E.W., UMBS, MICH, EGV]. Noted by Swift on the Fallass and Swift list as rare in waste places near Mackinaw City.

Solidago patula Willd. C.

Frequent in opener places, mossy bog forest by Crumley Creek, NE. ¼, Sec. 4, Ellis Tp., ca. 4 mi. SE. of Indian River, 1954 [E.G.V. 2545, UMBS, MICH, SMU, EGV]. Previously known as far north in the state as Grayling [G.H. Hicks in 1889, MICH], although reported from the Walloon River [Bear Creek] area near Petoskey by Coulter (1904, p. 42).

Solidago uliginosa Nutt. E. C.

This name was formerly applied to what is now called *S. purshii* (a name formerly used for *S. racemosa*), and all published records for *S. uliginosa* from the region appear to refer to *S. purshii*. True *S. uliginosa* (including what was formerly known as *S. neglecta* or *S. uniligulata*) has not been previously reported from the region. It is evidently much less common than *S. purshii*, from which it is quite distinct in its typical state but with which there are good arguments for uniting it (cf. Cronquist, Rhodora, 49: 70–73 [1947]). If treated as a separate species, the following collections of typical material may be cited: Near Harbor Springs, 1916 [Swift and C.W.F., ALBC].—Low pine plains, Cheboygan, 1890 [C.A.K., OC]. Cronquist (p. 71) states that both types are represented in Gleason and Gleason 298 from Cecil Bay; Grady L. Webster writes me that this collection (open swamp near shore of Lake Michigan, 1933) as represented in the Gray Herbarium has been determined as *S. purshii* by Fernald.

Tragopogon dubius Scop. [incl. *T. major* Jacq. Cf. Rhodora, 55: 325–328 (1953)] C.

With other weeds in waste ground, Mackinaw City, 1953 [E.G.V. 1740, UMBS]. More common in the region than this single collection would indicate.

Tragopogon porrifolius × *T. pratensis* C.

Discovered by L. H. Shinners in 1952 to be quite common with the parent species along railroad tracks just north of the station in Cheboygan [E.G.V. 1274, UMBS, EGV].

Xanthium spinosum L. E.

Rare, shore of Little Traverse Bay at Bay View, 1896 [C.W.F., ALBC]. The specimen is small, but can be referred to this species *sensu* Cronquist in Gleason (1952, iii: 374). The record was given by Wheeler (1899, p. 86) and McAtee (1923 p. 165).

Xanthium strumarium L. C.

This species (at least *sensu* Cronquist in Gleason[13]) is represented by a small plant from stony strand of Lake Huron at Point Nipigon, 1941 [F.C.G. 21367, UMBS]. Included (as "*X. canadense*") by Swift on the Fallass and Swift list with annotation that it is common in waste places. Seen in 1953 [C.E.W. and E.G.V.] in farmyard just E. of Riggsville Corners. No material has been found to support the Gates and Ehlers record of "*Xanthium* sp." from a hog-pen in Big Stone Bay.

LITERATURE CITED

Since a full bibliography is accompanying a companion paper (Voss, 1956) in connection with a history of floristics in the region, it seems unnecessary to repeat a large portion of it here. The present paper is a supplement to the Gates and Ehlers lists, and includes many references to the unpublished Fallass and Swift manuscript list:

Fallass, Charles W., and Charles H. Swift. 1918. A List of Plants (Pteridophytes, Gymnosperms, and Angiosperms) Found in Emmet and Cheboygan Counties, Michigan. Unpublished manuscript, the original of which has been lent me by Dr. Swift. Unless otherwise stated, all references are to this original list as compiled by both men, each contributing records in his own hand (cf. Voss, 1955), not to later copies of it.

Gates, Frank C., and John H. Ehlers. 1925. An Annotated List of the Higher Plants of the Region of Douglas Lake, Michigan. Mich. Acad. Sci., Arts, and Let., Papers, 4: 183–284.

1928. Additions to an Annotated List of the Higher Plants of the Region of Douglas Lake, Michigan. *Ibid.*, 8: 111–120.

—— 1931. Additions to an Annotated List of the Higher Plants of the Region of Douglas Lake, Michigan. II. *Ibid.*, 13: 67–88.

—— 1948. Additions to an Annotated List of the Higher Plants of the Region of Douglas Lake, Michigan. III. *Ibid.*, 32: 27–46.

Voss, Edward G. 1956. A History of Floristics in the Douglas Lake Region (Emmet and Cheboygan Counties), Michigan, with an Account of Rejected Records. Jour. Sci. Labs. Denison Univ., 44: 16–75.

[13] Note that Wiegand and Eames, in "The Flora of the Cayuga Lake Basin," p. 414, also suggested considerable reduction in the number of species to be recognized in *Xanthium*.

FORESTRY

Papers of the Michigan Academy of Science, Arts, and Letters
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POLYPORUS MINUSCULOIDES IN AMERICA

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Small specimens of polypores, especially soft white sessile species, are apt to be disregarded in field work because they appear immature. The species here reported was ignored for several years until an abundant collection demonstrated its diminutive size. In addition it has other unusual and interesting characteristics.

Polyporus minusculoides (Pilát) n. comb. (*Leptoporus minusculoides* Pilát, Atlas Champ. Europe 3: 193 [1938]) was described from two Czechoslovakian collections. No other collections have been reported. This species, however, is not uncommon in central and northern New York in late August and throughout September, on conifer logs which are usually moss-covered and in an advanced stage of decay. Specimens are never visible on the undisturbed log, as they occur in crevices on the protected lower side or, in severely decayed wood, in cavities throughout the log. Hemlock is the common substratum in New York.

Fresh specimens are snow-white, usually extremely soft, and almost always weakly attached by a narrowed apex, so that specimens are ordinarily pendent and conical (Fig. 1*A*, *B*). They may be sessile. The largest do not exceed 1 cm. in any dimension, and the smallest fertile specimen found consisted of only two tubes (Fig. 1*B*), making it one of the smallest if not the smallest of matured polypores. On drying, specimens shrink markedly, become fragile, and may discolor yellowish. They have an extraordinarily bitter taste. Brown rhizomorphs, as reported by Pilát (1936–1942, p. 193), were not found.

In longitudinal section the sporophore appears to be composed almost wholly of tubes (Fig. 1*C*), with the context reduced to a layer not exceeding 0.2 mm. in thickness. Pores in fresh specimens are angular and average 2–3 per millimeter (Fig. 1*D*). As for microscopic characteristics, the context hyphae are rarely branched, very thin-walled and often collapsing, 2–5 μ in diameter, and with abundant clamp connections; cystidia none; basidia clavate, 12–16 $\times$

FIG. 1. All *Polyporus minusculoides* with one exception. *A*, Characteristic sporophore, attached, × 1. *B*, Variation in size of sporophores, × 1. The second specimen from the left consisted of only two tubes. *C*, Longitudinal section of a sporophore, × 4.7. *D*, Pore surface in contrast with that of *P. subpendulus* (left side, photo courtesy Cornell University), × 6. *E*. Spores, Lowe No. 3751.

5–6 μ; spores hyaline, smooth, minutely apiculate, short-oblong to oblong-ellipsoid, 4–5.5 × 2–2.5 μ (Fig. 1*E*).

The fruiting body is similar to that of *Polyporus subpendulus* Atk., which differs from it most markedly in having much smaller pores, 6–7 per millimeter (Fig. 1*D*). *Polyporus minusculus* Boud. has exactly the same shape but darkens externally with age, has frequently septate hyphae and, according to the original description (Boudier, 1902, p. 141), globose spores 4–6 μ in diameter (spores not found on existing type material).

Specimens have been collected by me on hemlock or unidentified coniferous logs at Cazenovia, McConnellsville, and Warrensburg in New York, and by R. M. and M. Boarts on white pine at Indian Gap, Great Smoky Mountains National Park in Tennessee, at an elevation of 5000 ft (Lowe No. 3751). Material has been deposited in the herbaria of the following institutions: Cornell University; Farlow Cryptogamic Herbarium; National Fungus Collections at Beltsville, Md.; New York Botanical Garden; New York State Museum; University of Michigan; University of Tennessee; Kew,

England; Museum National d'Histoire Naturelle, Paris; and in the Riksmuseet, Stockholm, and at Upsala, in Sweden.

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Boudier, M. E. 1902. Champignons nouveaux de France. Soc. Mycol. France, Bull., 18: 135–146, pl. 6–8.

Pilát, A. 1936–1942. Polyporaceae. I–III. *In* C. Kavina and A. Pilát, Atlas des champignons de l'Europe. Vol. III, 624 pp., 374 pls. Prague.

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THE INFLUENCE OF SEED SOURCE ON THE DEVELOPMENT OF SCOTCH PINE AND NORWAY SPRUCE PLANTED IN LOWER MICHIGAN (FIFTEEN-YEAR RESULTS)

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Scotch pine (*Pinus sylvestris* L.) and Norway spruce (*Picea abies* (L.) Karst.), the two common European forest species, were the first forest trees extensively planted in the northern United States. Early plantings of these species in lower Michigan and elsewhere often gave poor results, partly because unsatisfactory seed sources were used. For a time, therefore, these species fell into disfavor, but large-scale Christmas-tree planting and a growing awareness by planters that better strains of Scotch pine and Norway spruce are available have resulted in their greater use in the past few years. The testing of exotic species of known origin becomes increasingly important with the discovery of more and more biotic enemies of our native pines.

It is of interest, therefore, to assess the results of a planting of Scotch pine and Norway spruce made in the spring of 1941 near Wellston, Michigan, on the Manistee National Forest. The planting stock was produced at Cass Lake, Minnesota, from seed received from the International Union of Forest Research Organizations to be used in an international test of seed source for these two species. World War II interfered with plans to carry out these tests on a uniform basis. The plots as established will serve as demonstrations of the growth and behavior of the various sources of Scotch pine and Norway spruce in comparison with native red and white pines of Michigan seed origin planted at the same time.

Establishing the Study

Twenty-two plots, 0.2 to 0.4 acre in size, were established on 6.9 acres within a level area of Grayling sand. Part of the area was open, and part of it carried a light cover of red oaks and aspen. Char-

TABLE I

Origin of the Seed Used*

Lot	Place of origin	North latitude	East longitude	Altitude above sea level, feet	Months with temperatures above 50° F.		Average annual precipitation, inches	Age of mother trees, years
					No.	Their average temp., °F.		
	Scotch Pine							
29	Bromarv, Finland	59°58′	23° 0′	49	4	56	23	—
30	Modum, Norway	60° 0′	10° 0′	650–1300	—	—	—	70–110
33	Breda, Netherlands	51°34′	4°46′	33	—	—	—	35
34	Tinocawa, Romania	47°14′	25°18′	3000	—	—	—	—
37	Suprasl "A," Lithuania (Poland)†	53°16′	23°19′	500–550	—	—	—	100
38	Suprasl "B," Lithuania (Poland)†	53°16′	23°19′	500–550	—	—	—	100
39	Bolewice, "A," Poland	52°21′	26°10′	260–330	—	—	—	80
53	Musteiki, Lithuania (Poland)†	54° 8′	24°25′	400–460	5	59	24	100
54	Rychtal, Poland	52° 0′	18° 5′	—	—	—	—	—
55	Luboml, White Russia (Poland)†	51°15′	24° 5′	590–620	5	61	23	110
	Norway Spruce							
1‡	Swiss Alps	47°±	9°±	3900–4600	—	—	—	—
2‡	Swiss Alps	47°±	9°±	4600–4900	—	—	—	—
8	Pförten, Poland (Germany)†	51°45′	14°50′	230	—	—	—	80–150
24	Hamar, Norway	60°30′	12°10′	750	3	56	24±	—
27	Srinosice, Czechoslovakia	49°40′	16°20′	1300±	5	57±	26±	—
28	Pokljuka, Jugoslavia	46°20′	13°50′	2650–2770±	5	57±	71±	—
29	Muntele, Romania	46°20′	25°50′	2300±	5	59±	23±	—
30	Valea Bistrei, Romania	46°20′	23° 0′	—	5	—	—	—
33	Vilno, Lithuania (Poland)†	54°40′	25°15′	525	5	61	22	—
34	Bialowiecza, Poland	52°40′	23°45′	—	—	—	—	—
35	Radom, Poland	51°25′	21° 5′	—	—	—	—	—
36	Dolina, Poland	48°55′	24° 0′	835–885±	5	60±	25±	—
P§	Wellston, Michigan	44°16′	85°57′‖	790	5	62	33	—

* Information on the localities of origin was obtained from Langlet (1953), Schenck (1939), and Vincent and Polnar (1953).

† The name in parentheses indicates the nation of origin at the time of collection.

‡ These lot numbers do not correspond to those in other reports of the International study.

§ P = planting site.

‖ West longitude.

acteristic ground cover included sweetfern (*Comptonia peregrina* (L.) Coult.), low-bush willow (*Salix humilis* Marsh.), grasses, and sedge (*Carex pennsylvanica* Lam.). On May 19 and 20, 1941, the trees were planted at a 6 × 6-foot spacing by the bar-slit method in east-west furrows plowed the previous fall.

The number of trees planted varied with the plot size and available supply but ranged from 104 to 462 trees per lot for the Scotch pine and from 104 to 447 for the Norway spruce.

Scotch pine seedlings (2–0) of ten European origins were planted in the more open portions of the area, and Norway spruce seedlings (2–0) of twelve European origins were set out in those portions of the area that had some overstory (Table I). Some pine was planted under cover, however, and some spruce in the openings. To provide uniform isolation rows and a measure of comparison with native species, each Scotch pine plot was surrounded by two or three rows[1] of 2–1 red pine transplants and each Norway spruce plot by two or three rows[1] of 2–1 white pine transplants.

Measuring Results

At the end of the first (1941), eleventh (1951), and fifteenth (1955) growing seasons in the field the trees were examined for survival, causes of loss or injury, and height growth. In 1941, 100 trees of each lot were examined for survival and measured for height. In 1951 a partial examination included 20 randomly selected trees per lot, 5 of which were measured for height. In 1955 again 100 trees[2] of each lot were examined for survival and condition and 20 of them were measured for height. The latter randomly selected trees were marked so that future measurements can be repeated on the same trees.

Current Results

Trees desirable for forest planting should combine good survival value with reasonably good growth and freedom from serious injury. How do the various lots of trees shape up in that respect?

[1] Two-row isolation strips were used where contiguous plots were planted with the same species; three-row strips where different species adjoined.

[2] Except for Norway spruce lots 2 and 24 and Scotch pine lot 39, where less than 100 trees had survived.

SURVIVAL

Early survival of the trees was excellent, but browsing by goats prior to fencing during the first year resulted in some damage and mortality, especially to the Norway spruce and white pine and, to a

TABLE II

SURVIVAL AND DEVELOPMENT OF SCOTCH AND ASSOCIATED RED PINES

Lot	Survival			Average heights				
	1941	1955		1941*	1951	1955		Extremes 1955
	Per cent	Per cent	Rank	Feet	Feet	Feet	Rank	Feet
Scotch Pine								
29	100	81	4	0.31	4.2	7.9	10	4.9–10.4
30	95	87	1	0.24	5.4	8.1	8	5.0– 9.6
33	96	78	5	0.29	5.9	11.6	3	9.3–13.5
34	98	75	6	0.27	4.9	8.0	9	4.4–10.5
37	98	83	2	0.30	6.6	10.8	4	7.7–13.6
38	100	78	5	0.28	7.9	10.4	5	6.0–14.2
39	100	83	2	0.32	7.5	12.0	2	11.0–14.1
53	96	83	2	0.30	6.4	10.1	6	7.8–12.5
54	100	78	5	0.33	7.5	12.2	1	10.1–14.3
55	100	82	3	0.35	7.8	9.3	7	5.8–12.9
All lots	98	81	—	0.30	6.4	10.0	—	4.4–14.3
Red Pine								
29	—	51	7	—	2.7	5.9	9	2.7–11.4
30	—	58	5	—	3.9	6.7	7	1.6–10.2
33	—	59	4	—	3.6	7.0	4	2.8–11.7
34	—	71	2	—	3.5	6.5	8	2.7–10.8
37	—	61	3	—	4.4	6.8	6	3.0–10.2
38	—	44	8	—	4.3	7.2	3	3.6– 9.0
39	—	83	1	—	3.4	6.9	5	4.3–11.4
53	—	58	5	—	3.4	7.3	2	1.8–11.2
54	—	71	2	—	3.9	6.8	6	3.4–13.0
55	—	55	6	—	4.8	7.7	1	4.0–12.2
All lots	—	60	—	—	3.8	6.9	—	1.6–13.0

* At time of planting.

TABLE III

SURVIVAL AND DEVELOPMENT OF NORWAY SPRUCE AND ASSOCIATED WHITE PINE

Lot	Survival			Average heights				
	1941	1955		1941	1951	1955		Extremes 1955
	Per cent	Per cent	Rank	Feet	Feet	Feet	Rank	Feet
Norway Spruce								
1	71	66	3	0.32	2.8	5.7	5	4.3– 9.6
2	78	65	4	0.29	2.6	5.1	7	1.6– 9.1
8	89	71	2	0.38	3.0	5.8	4	2.8– 9.1
24	52	33	9	0.28	1.2	4.0	9	1.4– 6.3
27	78	71	2	0.41	2.9	5.9	3	2.5– 9.1
28	81	59	5	0.31	1.9	3.8	10	1.2– 8.9
29	66	52	8	0.34	2.6	4.8	8	2.3– 8.2
30	81	52	8	0.39	2.9	5.7	5	2.3– 8.0
33	91	57	7	0.45	3.4	5.6	6	1.7– 8.4
34	90	58	6	0.41	2.4	6.0	2	3.1– 8.4
35	68	66	3	0.42	4.2	5.8	4	2.0– 8.1
36	82	74	1	0.33	3.2	7.3	1	3.6–11.0
All lots	77	60	—	0.36	2.8	5.4	—	1.2–11.0
White Pine								
1	—	56	7	—	4.5	9.3	3	5.2–11.9
2	—	45	10	—	3.9	8.5	6	4.7–11.0
8	—	46	9	—	4.0	7.2	10	4.0–10.0
24	—	40	11	—	4.2	7.8	8	4.4–11.1
27	—	76	3	—	4.2	8.8	5	5.2–11.8
28	—	66	5	—	4.9	8.9	4	5.4–12.0
29	—	59	6	—	4.6	9.4	2	7.0–11.4
30	—	56	7	—	4.2	8.5	6	6.5–10.8
33	—	49	8	—	3.0	7.2	10	4.4– 9.1
34	—	92	1	—	4.8	7.4	9	4.9–10.4
35	—	69	4	—	4.5	8.3	7	2.6–10.9
36	—	86	2	—	4.9	10.0	1	6.3–12.0
All lots	—	60	—	—	4.3	8.4	—	2.6–12.0

lesser extent, to the red pine. Poor planting and smothering by soil in deep furrows were the other main causes of mortality during the first year. Nevertheless, first-year survivals averaged 98 per cent (ranging from 95 to 100 per cent) for the Scotch pine (Table II), and 77 per cent (range, 52 to 91 per cent) for the Norway spruce (Table III). The red and white pines in the isolation rows were examined but not tallied at that time.

Ten years later, in 1951, a partial count indicated that survival of the Scotch pine still averaged 90 per cent (ranging from 80 to 95 per cent) as compared to 74 per cent (range, 60 to 85 per cent) for the associated red pine. The Norway spruce at that time averaged 73 per cent (range, 45 to 85 per cent), and the associated white pine 60 per cent (range, 35 to 80 per cent). The causes of mortality for the previous 10 years could no longer be identified. The principal causes evident were competition from overstory hardwoods for Norway spruce, white pine, and red pine, and the pine root-collar weevil (*Hylobius radicis* Buch.) for Scotch pine.

After 15 years in the field the average survival of Scotch pine is

TABLE IV

Cause of Injury to Scotch Pine, Observed during the Fifteenth Year in the Field

(Per cent)

Lot	Major causes of injury in living trees					Cause of death
	White-pine weevil		Oak-pine rust	Sap-sucker	Over-topping	Root-collar weevil
	New and old	New				
29	79	8				
30	89	7			10	
33	99	2	2	1	1	
34	75	8				
37	71	1			6	8
38	76	8	1		3	24
39	56	1	1		6	16
53	79	3	1		4	2
54	63	3	1	7		10
55	46	3			12	

81 per cent (range, 75 to 87 per cent), and that of the associated red pine is 60 per cent (range, 44 to 83 per cent) (Table II). The Norway spruce survival averages 60 per cent (range, 33 to 74 per cent), the same as the associated white pine (range, 40 to 92 per cent) (Table III). The causes of mortality in the past 4 years seldom could be identified, but root-collar weevil activity on Scotch pine has increased, especially in 5 central European lots in which the insect has killed from 2 to 24 per cent of the trees (Table IV). Because this insect is largely present in contiguous lots, the relative susceptibility of the various lots cannot be assessed accurately. Lot 53 from Lithuania, however, which has suffered very little damage and is situated between two heavily infested lots, may have some inherent resistance. In most lots of Norway spruce the hot dry summer of 1955 induced considerable drought loss.

Competition and associated drought were the chief causes of mortality among the red and white pines after first-year browsing losses. The pine root-collar weevil was noted as having killed 1 red pine sample tree in 1951 and another in 1955.

HEIGHT GROWTH

The height growth of all species was slow for the first 15 years, probably because of the poor site and injuries to the shoots (of Scotch pine, white pine, and Norway spruce).

So far Scotch pine has outgrown the other species. Although seedling heights were not significantly different at the time of planting, there were distinct differences 11 years later, and at the end of 15 years the variation between average heights for the various lots (from 7.9 to 12.2 feet) is highly significant according to the *F* test. The trees from seed origins in Finland (lot 29), Romania (lot 34), and Norway (lot 30) are distinctly shorter than those from the Netherlands (lot 33), Lithuania (lots 37, 38, and 53), Poland (lots 39 and 54), and White Russia (lot 55) (Table II). At this age the various Scotch pine lots show a spread of 4.3 feet in average height as compared to 1.8 feet for the associated red pine.

Norway spruce has made the poorest growth to date. Total heights were quite comparable among lots at the time of planting, but 11 years later there were marked differences. At the end of 15 years the variation between average heights for the various lots (3.8 to 7.3 feet) is highly significant according to the *F* test. Per-

centagewise the variation is greater than among the Scotch pine lots. Lot 36 of Polish origin (7.3 feet) has made the best height growth (Table III). Lot 28 from Jugoslavia (3.8 feet) and lot 24 from Norway (4.0 feet) have made the poorest height growth. The remaining lots are fairly uniform; they range from 4.8 to 6.0 feet tall.

At the end of 15 years in the field red pine averages 6.9 feet tall, a mean gain of 3.1 feet in the last 4 years (Table II). Since only one seed source is represented, height growth was expected to be fairly uniform from plot to plot. Percentagewise the variation from plot to plot is about one-third to one-half that for Scotch pine. On the average the Scotch pine is 3.1 feet (45 per cent) taller than the red pine.

At the same age white pine averages 8.4 feet tall as compared to 4.3 feet 4 years ago (Table III). Although only one seed source is represented, its height growth has been a little less uniform than that of red pine but distinctly more uniform than that of either Scotch pine or Norway spruce. Percentagewise the variation from plot to plot is about one-half that for the associated Norway spruce. The height growth of white pine during the last 4 years has been greater than that of the other three species in the study.

CAUSES OF INJURY

Injuries commonly reduce growth and often pave the way for later mortality. Some injury factors, such as smothering by litter or soil after planting, were non-selective and affected all species. Others, such as the oak-pine rust and the sapsucker, damaged only one species.

Scotch pine has been injured by more agents than any of the other three species (Table IV). The most common source of injury has been the white-pine weevil (*Pissodes strobi* (Peck)). In 1951 this insect was present in all lots and had attacked 57 per cent of the trees examined. By 1955 the weevil had attacked 73 per cent of all trees examined. The lots from Holland (No. 33) and Norway (No. 30) had been most affected (99 and 89 per cent, respectively). The least injured lots include 1 from White Russia (No. 55), and 2 from Poland (Nos. 39 and 54), with 46, 56, and 63 per cent injury, respectively. New attacks during 1955 were noted on 1 to 8 per cent of the trees of the various lots. Weeviling has reduced the height of the Scotch pines considerably. The oak-pine rust (*Cro-*

TABLE V

CAUSE OF INJURY TO NORWAY SPRUCE, OBSERVED DURING THE FIFTEENTH YEAR IN THE FIELD

(Per cent)

Lot	Causes of injury (1955)			
	White-pine weevil	Drought	Frost	Winter injury
1	11	4	0	4
2	7	5	9	7
8	7	1	2	0
24	6	4	10	4
27	1	1	3	12
28	27	2	5	6
29	18	1	0	12
30	14	16	18	5
33	14	3	4	10
34	9	2	3	3
35	6	2	6	10
36	13	11	0	4

nartium cerebrum Hedgc. and Long) was present to a limited extent on 5 lots. Sapsuckers (*Sphyrapicus varius varius* (Linnaeus)) damaged trees in 2 lots; 7 per cent of those on 1 Polish lot (No. 54) and 1 per cent of those on 1 Netherlands lot (No. 33) were so affected. From 1 to 12 per cent of the trees in 7 lots had suffered reduced height growth from being overtopped by the scattered oak and aspen overstory.

Norway spruce so far has been affected much less by insects than Scotch pine. During the first year in the field a 2 per cent mortality was caused by the feeding of grasshoppers (*Melanoplus* spp.) and white grubs (*Phyllophaga* spp.). By the eleventh year after planting the white-pine weevil had attacked 4 per cent of the spruce trees planted, although only 4 lots had been affected. By the fifteenth year after planting, 11 per cent of the trees were weeviled and all lots had been attacked (Table V).

Heaviest infestation, 27 per cent, occurred in a lot from Jugoslavia (No. 28), and the lightest was in a lot from Czechoslovakia (No. 27); these lots were adjacent to each other. The eastern

spruce gall aphid (*Chermes abietis* L.) has appeared on 1 tree in 1 lot (No. 33) from Lithuania.

Physical factors of environment also brought about injury to Norway spruces. The summer drought of 1955 reduced the crowns of many of the spruces through dieback from the tops. A severe frost late in the spring of 1955 caused considerable damage to lots from Switzerland (No. 2), Norway (No. 24), and Romania (No. 30) (Table V). On the other hand, lots from a lower elevation in Switzerland (No. 1), from another locality in Romania (No. 29), and from other central European localities were only lightly injured. Some lots which escaped late spring frost damage had already suffered considerable winter injury, however. These include lots from Czechoslovakia (No. 27), Romania (No. 29), Lithuania (No. 33), and Poland (No. 35). These injuries from drought, frost, and winter conditions have reduced the height growth of the spruces so affected.

The associated red and white pines were not examined at the end of the first year, but it was reported that both species suffered from goat browsing at that time. The white-pine weevil has injured 44 per cent of the white pines during the first 15 years and has reduced the height growth of the affected trees. Only 1 red pine has been attacked by the weevil, but the proportion probably will increase if experience with other red pine plantations in the vicinity is a good guide.

Evaluating the Results

The seed for the Scotch pine and Norway spruce lots planted in this test originated from 2 to 16 degrees of latitude (about 140 to 1100 miles) farther to the north than the lower Michigan planting site (Table I) (Langlet, 1953; Schenck, 1939; Vincent and Polnar, 1953). Most of the localities of origin have about the same length of good growing period (temperatures of 50° F. or above) as the planting site, but their average temperatures for that period are lower. Except for the Jugoslavian locality (71-inch annual rainfall), all the places of origin have only 70 to 75 per cent of the annual rainfall normal at the planting site. It would appear, therefore, that these exotic species ought to be reasonably hardy in the plantation locality. In general this has proved true, although Norway spruce, the more tender species, has suffered some mortality from drought and some injury from late frosts and winter conditions.

Fifteen-year results of this test seem to indicate that nothing

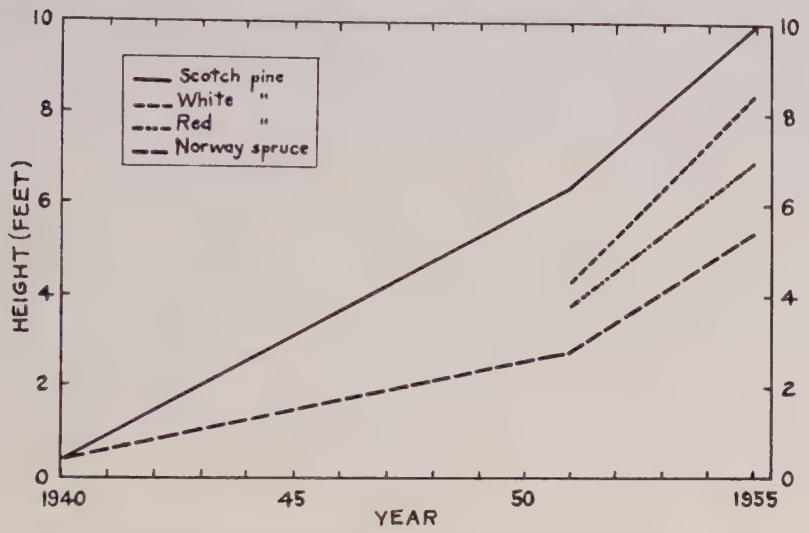

FIG. 1. Average height of Scotch pine, white pine, red pine, and Norway spruce after 15 years.

is to be gained by substituting trees of these particular seed sources of Scotch pine and Norway spruce for native red and white pines in this part of lower Michigan. The present superiority in survival and total height of the better Scotch pine lots is more than offset by the much larger number of damaging agents to which they have become increasingly subject.

Height growth curves (Fig. 1) indicate a trend which probably will become more pronounced as the plantings grow older. White pine height growth should soon equal and exceed that of the Scotch pine. Red pine, by virtue of its relative freedom from top-damaging agencies, should catch up to Scotch pine. Of course, infestation by the European pine shoot moth now present in the county, but not in the planting, could change this picture in view of its known preference for red pine. Because Scotch pine grown beyond Christmas tree size also is severely damaged by the shoot moth, however, the planting of resistant white pine and Norway spruce may become more attractive as this insect spreads. In its favor, Norway spruce also has the additional feature of producing valuable long-fibered woodpulp. If suitable sources can be found, therefore, Norway spruce could fill an ecological niche on sandy sites where the native white spruce may not thrive.

Future observations may be of value in showing not only the susceptibility of various species and lots to damaging agents but also their ability to recover from injuries.

SUMMARY

In the spring of 1941, near Wellston, Michigan, Scotch pine of ten and Norway spruce of twelve European origins were planted on a sandy, relatively open site in association with red pine and white pine of Michigan origin. Initial survival and growth were adversely affected by goat browsing during the first year. At the end of 15 years, however, Scotch pine has the best survival (81 per cent) and the other three species are uniformly lower (each averages 60 per cent). Scotch pine made the best height growth, with various lots ranging from 7.9 feet (Finland) to 12.2 feet (Poland). Norway spruce made the poorest height growth with averages ranging from 3.8 feet (Jugoslavia) to 7.3 feet (Poland). Red pine averages 6.9 feet and white pine 8.4 feet at this age.

Scotch pine shows evidence of increasing injury from the white-pine weevil, the root-collar weevil, and other insects. White pine has been commonly injured by the white-pine weevil. Some lots of Norway spruce also have been injured by this insect. The spruce has also suffered from drought, frost, and winter injury. Red pine has been essentially free of injury. As a result of these conditions it appears likely that red pine will equal and white pine will overtake and exceed Scotch pine in height within a few years.

The conclusion at the end of 15 years in the field is that the native white pine and red pine will give more satisfactory results when planted on this site. It is recognized, however, that longer observation is needed to show whether or not any of the origins of Scotch pine or Norway spruce under test will be useful under these conditions.

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ZOOLOGY

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A REVISION OF THE FAMILY DRYOMYZIDAE (DIPTERA, ACALYPTRATAE)

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The Dryomyzidae are medium-sized to large flies usually found in humid localities with low vegetation. It has been stated that the larvae occur in fungi and human excrement, but very little is known concerning either their habits or life history.

Taxonomically, these flies belong to a section of the Acalyptratae whose relationships are in considerable doubt owing to paucity of data. It is hoped that the data here presented will assist in eventually arriving at a satisfactory classification. By removal of genera which are referable to the Coelopidae, Helcomyzidae, or other families, a residue is obtained which consists of three nominal genera, as in the following table adapted from Hendel (1937: 186):

1. Wing vein R_1 setose above; intra-alar bristle present; supra-alar preceded by 2 or 3 shorter bristles; anterior frontal margin extending over the lunule and antennal bases 2
   Vein R_1 without setae; supra-alar bristle preceded by short hairs only; anterior frontal margin shallowly emarginate, exposing the lunule and antennal bases; prostigmatic bristle lacking ..... *Dryomyza* Fallén
2. Prostigmatic bristle lacking; ultimate section of vein M_1 curved forward, cell R_5 distally narrowed; arista long-plumose in distal half .. *Stenodryomyza* Hendel
   Prostigmatic bristle present; vein M_1 curved backward distally; arista with short hairs in basal half ..... *Neuroctena* Rondani

The characters cited in the above table do not hold for all the species which have been referred to the several genera. For example, the row of shorter bristles anterad of the supra-alar is present only in *Stenodryomyza formosa*; the anterior frontal margin in *Neuroctena simplex* also is emarginate enough to expose the lunule and antennal bases; the prostigmatic bristle is lacking in *Neuroctena simplex* and *N. fumida* (= *setosa*, v.i.); and the new species *bergi* lacks setae on vein R_1, although the frontal margin overhangs the lunule. The use of additional characters such as the presence or absence of prescutellar acrostichal bristles and the characters of the male terminalia

leads to a further breakdown of generic distinctions in the group, and the intermediate development of the setae of R_1 in *Neuroctena fumida* and the delicate or lacking prostigmatic bristle in the new species *puellaris* also contribute to the breakdown. I cannot do otherwise than consider the various species as members of a single genus, the one first described, *Dryomyza*.[1]

The group as at present constituted is of purely holarctic distribution; two of the species are also holarctic. All species would seem to be of relatively ancient origin and well stabilized morphologically, since the main points of variation are restricted to coloration and size of bristles, and those in some degree at least correlated with absolute body size.

Genus *Dryomyza* Fallén[2]

1820, Sciom. Sveciae: 15, with two species, type species *Musca flaveola* Fabr., the first species (as *D. vetula*), by designation of Westwood, 1840; Meigen, 1826, Syst. Beschr., 5: 255; Westwood, 1840, Intr. Mod. Class. Ins., 2: 145; Zetterstedt, 1846, Dipt. Scand., 5: 2081; Schiner, 1864, Fauna Austriaca, 2: 39; Becker, 1905, Kat pal. Dipt., 4: 37; Aldrich, 1905, Smithsonian Misc. Coll., 46 (Cat. No. Am. Dipt.): 578; Coquillett, 1910, U. S. Nat. Mus. Proc., 37: 535; Cresson, 1920, Am. Entom. Soc., Trans., 46: 31; Melander, 1920, Entom. Soc. Am., Ann., 13: 307; Hendel, 1923, Konowia, 2: 212; Czerny, 1930, *in* Lindner, Die Fliegen d. pal. Reg., 5 (fasc. 38a): 1; Brues and Melander, 1932, Mus. Comp. Zool., Bull., 73: 327; Malloch, 1933, Dipt. Patagonia and So. Chile, pt. 6, fasc. 4: 296; Curran, 1934, Fam. Gen. No. Am. Dipt.: 382; Séguy, 1934, Faune de France, 28: 86; Hendel, 1937, Naturhist. Mus. Wien, Ann., 48: 183; Hennig, 1937, *in* Lindner, Die Fliegen d. pal. Reg., 5 (fasc. 52): 1; 1952, Die Larvenformen d. Dipt., 3: 244; Colyer and Hammond, 1951, Flies of the Brit. Isles: 206; Brues, Melander, and Carpenter, 1954, Mus. Comp. Zool., Bull., 108: 367.

Dryope Robineau-Desvoidy, 1830, Essai Myod.: 618, with two species, type species *Musca flaveola* Fabr., the second species (as *Dryope communis*) by designation of Coquillett, 1910.

Neuroctena Rondani, 1868, Atti Soc. Ital. Sci. Nat., 11: 56, with one species, *Dryomyza anilis* Fallén.

Stenodryomyza Hendel, 1923, Konowia, 2: 214, as subgenus of *Neuroctena*, with one species, *Scatophaga formosa* Wiedemann. *New Synonym.*

[1] The genus *Sciogriphoneura* Malloch, 1933, Dipt. Patagonia and So. Chile, pt. 6, fasc. 4: 300, has most of the general characters of Dryomyzidae, *sensu strictu*, but the terminalia of a male specimen in the United States National Museum are quite different from the forms here treated.

[2] All general references except those to the original descriptions of synonymous genera are listed under *Dryomyza*.

KEY TO KNOWN SPECIES OF THE GENUS *DRYOMYZA*

1 (6). Wing vein R_1 without setae dorsally, at most with 1 or 2 near apex; prescutellar acrostichal bristles present (weak in *D. melanderi*); prostigmatic bristle small and fine or absent

2 (3). Pterostigma brown; crossveins and apex of longitudinal veins with heavy brown spots; *male*: terminalia with surstyli similar to those of *D. flaveola*, but considerably longer (cf. Fig. 6) (Northwestern North America)
D. melanderi, nom. nov.

3 (2). Wings with yellow or hyaline pterostigma and with at most but weak spots (cf. also *D. ferruginea*, *D. decrepita*, and *D. senilis* in text following)

4 (5). Anterior frontal margin shallowly emarginate, exposing lunule and antennal bases; *male*: hind femora below with hairs nearly as long as diameter of femora; hind basitarsi with sharp curved hook apicoventrally; terminalia as in Figure 5, aedeagus with pile posteriorly and without anterior subbasal pair of teeth (Holarctic) ..... *D. flaveola* (Fabr.)

5 (4). Anterior frontal margin straight, covering lunule and antennal bases; *male*: hind femora with very short, pile-like hairs below; hind basitarsi with blade-like process apicoventrally; terminalia as in Figure 2, aedeagus with bare membrane posteriorly and with anterior subbasal pair of teeth (Alaska) ..... *D. bergi*, sp. nov.

6 (1). Vein R_1 with numerous setae, extending from apex at least halfway to origin of Rs; prescutellars and prostigmatic bristle present or absent

7 (12). Prescutellars present; middle tibiae usually with 4 or 5 medial posterior bristles; lunule covered; squamal ciliae yellowish

8 (9). Arista plumose to middle; prostigmatic bristle absent; vein M_1 curved forward in ultimate section; supra-alar preceded by a few shorter bristles; strong intra-alar present; very large species (wing length 18 mm.) with heavy blackish spots at crossveins and tips of Sc and M_1 (Oriental)
D. formosa (Wied.)

9 (8). Arista practically bare; vein M_1 not curved forward; prostigmatic bristle usually present (fine or sometimes lacking in *D. puellaris*); intra-alar occasionally developed in *D. anilis* only

10 (11). Wing membrane about crossveins distinctly infumated; prostigmatic bristle usually strong; antennae, palpi, and legs uniformly yellowish; abdomen usually yellow or brown, shining (Holarctic) ..... *D. anilis* Fallén

11 (10). Wings uniformly hyaline; prostigmatic bristle small and fine or sometimes lacking; antennae, palpi, and tips of femora and tibiae black; abdomen blackish except at base and tip, overlaid with gray pruinosity (China)
D. puellaris, sp. nov.

12 (7). Prescutellar and prostigmatic bristles absent; arista pubescent or plumose; middle tibiae with 0–2 posterior median bristles; wings not spotted; *male*: without spurs at apex of fore and hind basitarsi.

13 (14). Vein R_1 setose from tip to origin of Rs; arista plumose; abdomen and tarsi yellow; lunule exposed; squamal ciliae brown to black; *female*: tip of abdomen without denticles (Eastern North America) .... *D. simplex* Loew

14 (13). Vein R_1 setose from tip halfway or two-thirds of the distance to origin of Rs; arista pubescent; abdomen and tarsi blackish; *female*: apical abdominal segments with small, stout denticles (Western North America)

D. setosa (Bigot)

Dryomyza anilis Fallén

(Fig. 1)

1820, Sciom. Sveciae: 16, Meigen, 1826, Syst. Beschr., 5: 257; Macquart, 1834, Hist. Nat. Ins. Dipt., 2: 396; Zetterstedt, 1838, Ins. Lapp.: 736; 1846, Dipt. Scand., 5: 2082; Scholtz, 1850, Zeits. f. Entom. Breslau, 4: 32; Walker, 1853, Ins. Brit., 2: 164; Loew, 1862, Mon. Dipt. No. Am., 1: 128; Schiner, 1864, Fauna Austriaca, 2: 39.

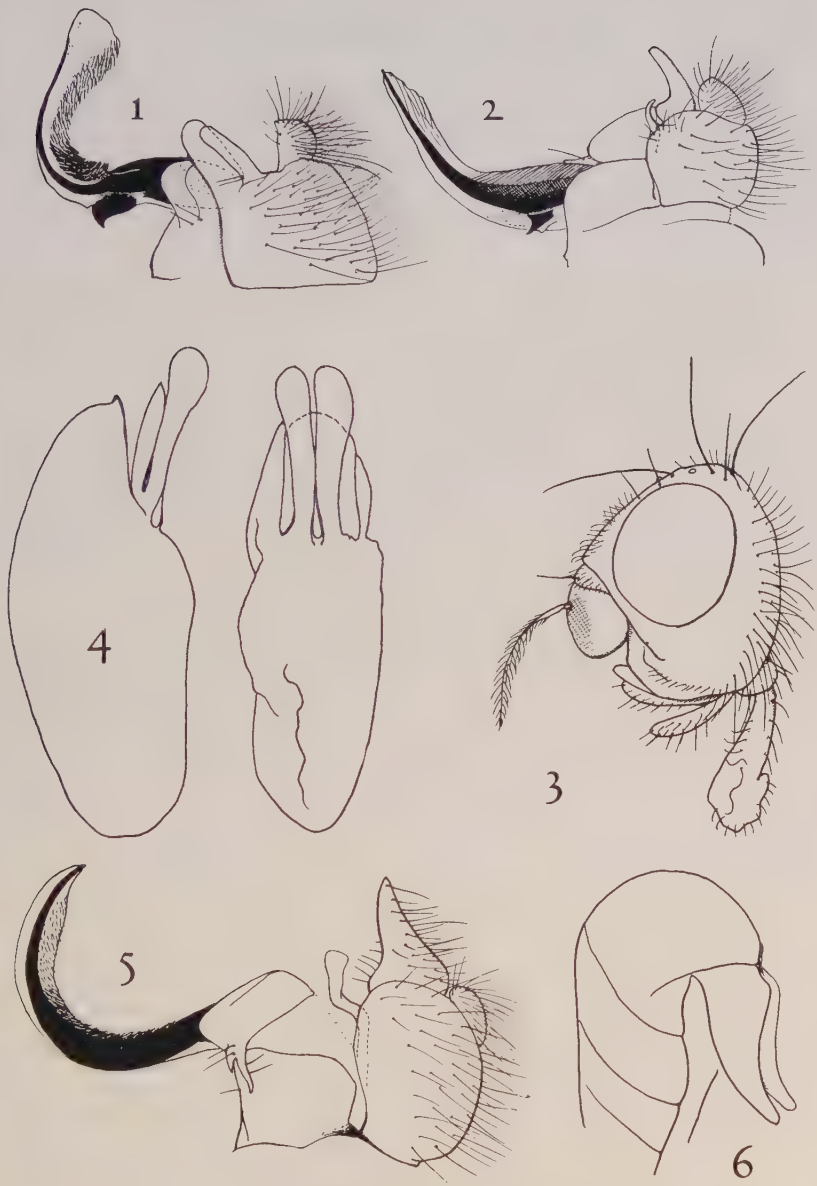
Dryope liturata Robineau-Desvoidy, 1830, Essai Myod.: 618.

Neuroctena anilis (Fallén) Rondani, 1868, Atti Soc. Ital. Sci. Nat., 11: 56; 1869, Prodr. Dipt. Ital., 7(3): 9; Brauer, 1883, Denkschr. K. Akad. Wiss., 47: 86; Bezzi, 1903, Riv. Ital. Speleol., 1: 8; Hine, 1904, Can. Entom., 36: 92; Becker, 1905, Kat. pal. Dipt., 4: 37; Aldrich, 1905, Smithsonian Misc. Coll., 46 (Cat. No. Am. Dipt.): 578; Bezzi, 1907, Atti Soc. Ital. Sci. Nat., 46: 11; Smith, 1910, New Jersey St. Mus., Ann. Rep. for 1909: 796; Portschinsky, 1910, Chem. Bur. Entom. Sci. Comm. Centr. Bd. Land Admin. Agric. (Trudy Bur. Entom.), 8(8): 84; Van Duzee, 1911, Can. Entom., 43: 243; Walker, 1913, Nat. Hist. Toronto Reg.: 395; Gibson, 1916, Entom. Soc. Ontario, Ann. Rep., 46: 218; Britton, 1920, Connecticut Geol. Nat. Hist. Surv., Bull., 31: 201; Cresson, 1920, Am. Entom. Soc., Trans., 46: 32; Melander, 1920, Entom. Soc. Am., Ann., 13: 311; Cole and Lovett, 1921, California Acad. Sci., Proc., (4)11: 322; Johnson, 1925, Boston Soc. Nat. Hist., Occ. Papers, 7: 248; 1927, Biol. Surv. Mt. Desert Reg., pt. 1: 214; Leonard, 1928, Cornell Univ. Agric. Exp. Sta., Mem., 101: 845; Czerny, 1930, *in* Lindner, Die Fliegen d. pal. Reg., 5 (fasc. 38a): 4; Petch and Maltais, 1932, Quebec Soc. Prot. Plants, 24th Ann. Rep., suppl.: 68; Séguy, 1934, Faune de France, 28: 88; Eidmann, 1935, Arb. Morph. Tax. Entom. Berlin-Dahlem, 2: 99; Hennig, 1937, *in* Lindner, Die Fliegen d. pal. Reg., 5 (fasc. 52): 3; Brimley, 1938, Ins. No. Carolina: 378; Colyer and Hammond, 1951, Flies of the Brit. Isles: 206; Hennig, 1952, Die Larvenformen d. Dipt., 3: 244.

Dryomyza pallida Day, 1881, Can. Entom., 13: 89.

This species should be easily recognized by the use of the key and the figure of the male terminalia (Fig. 1). The males are furnished with a small, apicoventral spur on the fore and hind basitarsi.

Dryomyza anilis is by far the commonest species of the family. It is widely distributed in the Palaearctic Region—I have seen material from Scotland, Netherlands, Sweden, and Austria. I have seen North American material from Alaska (Fort Wrangell; Howcan; Kadiak; Kukak Bay; Matanuska; Port Chester; Seward; Virgins Bay; Yakutat), Ontario (Sault Ste. Marie), Labrador (Square Id., 52°44′ N., 55°44′ W.), Washington, South Dakota, Minnesota, Iowa,



Details of *Dryomyza* Species

FIG. 1. *Dryomyza anilis* Fallén, male terminalia
FIGS. 2–3. *D. bergi*, sp. nov., holotype, male: 2, terminalia; 3, head
FIGS. 4–5. *D. flaveola* (Fabr.): 4, egg; 5, male terminalia
FIG. 6. *D. melanderi* Steyskal, male, tip of abdomen of paratype

Illinois, Michigan, New York, Pennsylvania, New Hampshire, Massachusetts, Connecticut, and Maine. There are also records in the literature of specimens from British Columbia, South Labrador (Trout Lake), Nova Scotia (Antigonish), Oregon (Corvallis), Vermont, Rhode Island, New Jersey, and North Carolina (Mt. Mitchell).

Dryomyza bergi Steyskal, sp. nov.

(Figs. 2–3)

Male.—Length of wing, 6.4 mm.

General color tawny, all the tarsi blackish, third antennal segment brown dorsally, thorax with brownish middorsal longitudinal stripe. Wings yellowish hyaline, without markings or spots; veins yellowish to light brown. All bristles and hairs black, except yellowish hairs toward apex of arista and long pale yellow squamal ciliae.

Head as in Figure 3; anterior frontal margin straight, extending over lunule and antennal bases; arista with long pubescence.

Thoracic chaetotaxy as follows: prosternum bare; 1 long propleural; 1 weak prostigmatic; 1 + 3 long sternopleurals; 1 humeral; 2 notopleurals; 1 sublateral; 1 supra-alar; 2 postalars; 2 dorsocentrals; 1 pair of strong prescutellar acrostichals; 4 scutellars.

Wing vein R_1 with 2 small setae dorsally near apex, otherwise bare; last section of vein M_1 slightly arcuate, practically parallel with R_5.

Middle tarsi with 3–4 short medial posterodorsal bristles. Fore and hind basitarsi with short laminar apicoventral process. Hind femora with short pile below.

Terminalia as in Figure 2; surstyli with heavy anterobasal shoulder; epandrium (hypopygium) with short but slender, backwardly curved process anteroventrally; aedeagus bare, with a slender dark sclerotic rib along each side and with a sharp tooth at each side near base.

Female.—Similar to male, but lacking the processes of the fore and hind basitarsi. Hind femora below with hairs about half as long as the dorsoventral thickness of the femora. Abdomen subshining, with slender hairs and bristles.

Holotype (male), Lower Yukon River, Alaska, June 27, 1951 (C.

O. Berg); *allotype* (female), Matanuska, Alaska, Oct. 6, 1945, rotary trap (J. C. Chamberlin); both in United States National Museum.

I am pleased to dedicate this species to the collector of the holotype, my friend Clifford O. Berg. It may be distinguished from its congeners as in the preceding table.

Dryomyza decrepita Zetterstedt

1838, Ins. Lapp.: 737; 1846, Dipt. Scand., 5: 2085; Czerny, 1930, *in* Lindner, Die Fliegen d. pal. Reg., 5 (fasc. 38a): 3; Séguy, 1934, Faune de France, 28: 88.

This form is distinguished from *D. flaveola* by having brownish clouds on the crossveins, but, as stated under *D. flaveola*, I seriously doubt its distinctness. Known only from northern Europe. A male Alaskan specimen which exhibits the characters attributed to *D. decrepita* has terminalia typical of *D. flaveola*.

Dryomyza ferruginea Melander

1920, Entom. Soc. Am., Ann., 13: 311; Johnson, 1925, Boston Soc. Nat. Hist., Occ. Papers, 7: 248; 1927, Biol. Surv. Mt. Desert Reg., pt. 1: 214; Strickland, 1946, Can. Jour. Res., (D)24: 168.

I have not been able to examine material referable to this species, which Melander distinguished from *D. flaveola* (as *D. dayi*) as follows:

Third vein recurved, ending beyond wing-tip, the submarginal cell twice as wide as the first posterior along the costa; pilosity of arista very fine and rather sparse *D. flaveola*

Third vein less recurved, the first posterior cell two-thirds as wide as the submarginal cell along the costa; arista blackish and distinctly pilose; hypopygium large, the paramera hook-like ..... *D. ferruginea*

The types are two males from Vermont in the Melander collection; Johnson recorded the species from Maine, and Strickland reported it from Alberta. I cannot regard the distinctions cited by Melander as of moment and consider that recognition of *D. ferruginea* must await type examination.

Dryomyza flaveola (Fabricius)

(Figs. 4–5)

Musca flaveola Fabricius, 1794, Entom. Syst., 4: 343; 1805, Syst. Antl.: 306.
Dryomyza flaveola (Fabricius) Meigen, 1826, Syst. Beschr., 5: 256; Macquart, 1834,

Hist. Nat. Ins. Dipt., 2: 396; Zetterstedt, 1838, Ins. Lapp.: 736; 1846, Dipt. Scand., 5: 2804; Walker, 1853, Ins. Brit., 2: 164; Schiner, 1864, Fauna Austriaca, 2: 40; Rondani, 1869, Prodr. Dipt. Ital., 7: 74; Hensel, 1870, Berlin. Entom. Zeits., 14: 133; Girschner, 1883, Katt. Entom. Nachr., 9: 201; Becker, 1906, Kat. pal. Dipt. 4: 37; Czerny, 1930, *in* Lindner, Die Fliegen d. pal. Reg., 5 (fasc. 38a): 3; Séguy, 1934, Faune de France, 28: 88; Colyer and Hammond, 1951, Flies of the Brit. Isles: 206.

Dryomyza communis Robineau-Desvoidy, 1830, Essai Myod.: 618.

Dryomyza vetula Fallén, 1820, Sciom. Sveciae: 16.

Dryomyza fuscicornis Meigen, 1838, Syst. Beschr., 7: 343; Becker, 1902, Zeits. f. Hymenop. u. Dipt., 2: 219.

Dryomyza mollis Haliday, 1833, Entom. Mag., 1: 167.

Dryomyza zawadskii Schummel, 1833, Jahresber. deutsch. Naturf. Breslau; 1834, Oken's Isis for 1834: 741; Schiner, 1864, Fauna Austriaca, 2: 40; Hensel, 1870, Berlin. Entom. Zeits., 14: 133; Czerny, 1930, *in* Lindner, Die Fliegen d. pal. Reg., 5 (fasc. 38a): 3; Séguy, 1934, Faune de France, 28: 88.

Dryomyza dayi Cresson, 1920, Am. Entom. Soc., Trans., 46: 34; Johnson, 1925, Boston Soc. Nat. Hist., Occ. Papers, 7: 248; 1927, Biol. Surv. Mt. Desert Reg., pt. 1: 214; Leonard, 1928, Cornell Univ. Agric. Exp. Sta., Mem., 101: 845. *New Synonym.*

The characters cited in the above key and the male terminalia as shown in Figure 5 will distinguish *D. flaveola* from all described species except *D. ferruginea*, *D. decrepita*, and *D. senilis*, which I have been unable to recognize. I am very doubtful whether *D. decrepita* and *D. senilis*, both so far recorded only from the Palaearctic Region are distinct from *D. flaveola*. These forms are distinguished by Czerny as follows:

1. Crossveins infumated ..... *D. decrepita*
   Crossveins not infumated 2
2. Third antennal segment strongly darkened, almost brown; tarsi black toward apex *D. flaveola*
   Third antennal segment reddish yellow; tarsi wholly black ..... *D. senilis*

For further discussion see under the various names. *Dryomyza zawadskii* has been shown to be an autumnal generation of *D. flaveola*.

An egg dissected from a Katahdin, Maine, specimen is shown in Figure 4. The only other data concerning the immature stages of a Dryomyzid is in Portschinsky (1910), cited by Hennig (1952), with reference to *D. anilis*.

I have seen European material from England, Scotland, Sweden, Germany, France, Austria, Hungary, and Macedonia, including males from Germany and Austria which have terminalia agreeing with American material I have examined from Alaska (Matanuska),

British Columbia (Carbonate, Columbia River), Nova Scotia (Digby; Truro), Kansas (Spearville), Michigan (Roscommon County), New York (Ithaca, including holotype of *D. dayi*; Oneonta; Rome; Trenton Falls), Pennsylvania (Hazleton), and Maine (Katahdin).

Dryomyza formosa (Wiedemann)

(Fig. 7)

Scatophaga formosa Wiedemann, 1830, Auss. Zweifl., 2: 447; Loew, 1858, Wien. Entom. Monatschr., 2: 112.

Dryomyza maculipennis Macquart, 1850, Dipt. Exot., suppl., 4: 273; Bigot, 1892, Jour. Asiatic Soc. Bengal, (2) 2: 209; Brunetti, 1907, Rec. Ind. Mus., 1: 169.

Dryomyza gigas Snellen van Vollenhoven, 1862, Versl. Meded. K. Akad. Wetensch., 15: 18.

Dryomyza formosa (Wiedemann) Osten-Sacken, 1887, Wien. Entom. Ztg., 1: 20; Van der Wulp, 1896 Cat. Dipt. So. Asia: 163; Lichtwardt, 1909, Deutsche Entom. Zeits. for 1909: 127.

Eggizoneura formosa (Wiedemann) Coquillett, 1899, U. S. Nat. Mus., Proc., 21: 339.

Neuroctena (*Stenodryomyza*) *formosa* (Wiedemann) Hendel, 1923, Konowia, 2: 214.

Stenodryomyza formosa (Wiedemann) Czerny, 1930, *in* Lindner, Die Fliegen d. pal. Reg., 5 (fasc. 38a): 5; Hendel, 1937, Naturhist. Mus. Wien, Ann., 48: 186.

Neuroctena formosa (Wiedemann) Wu, 1940, Cat. Ins. Sinens., 5: 385.

This species may be recognized by its size alone (wing length, 18 mm.); the male terminalia are shown in Figure 7.

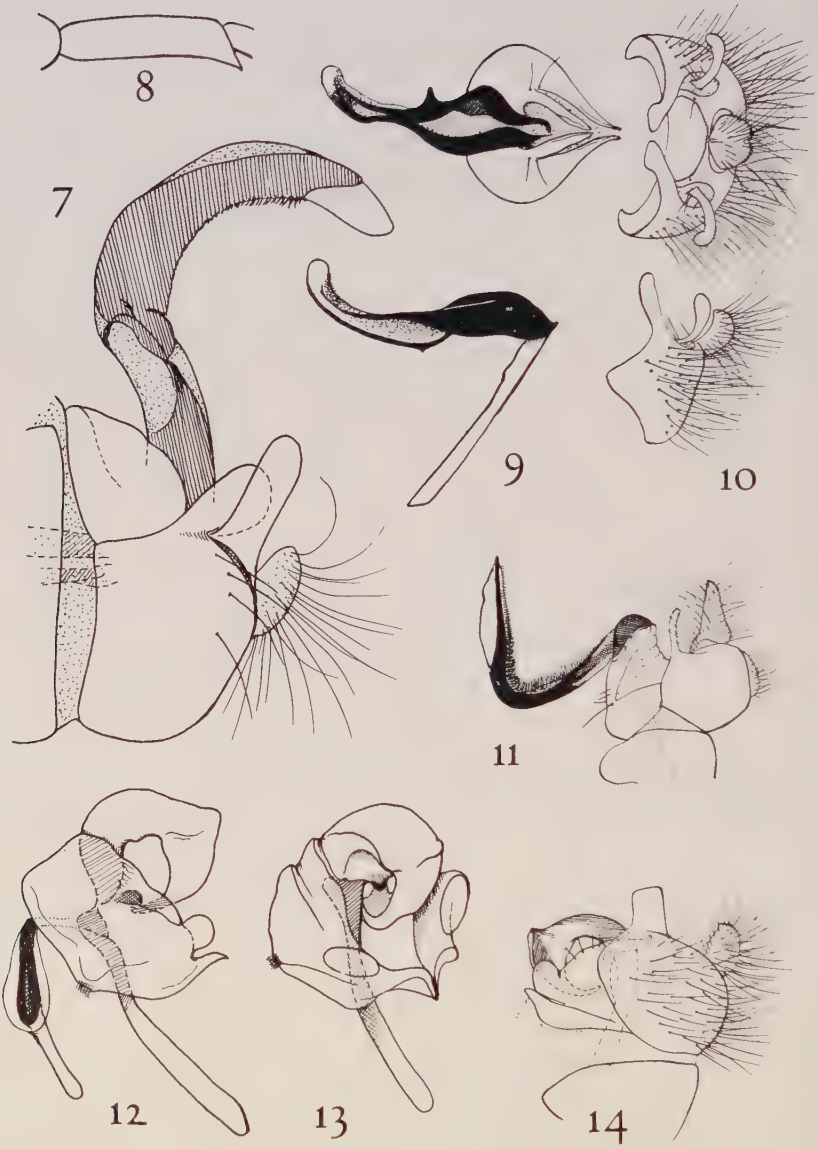
I have seen it from Japan (Hakone; Kobe; Lake Towada; Sapporo) and China (Suifu, now Ipin, Szechwan). Wu lists "China; Formosa, Japan," but the reference to Formosa is likely a *lapsus*. Macquart's type was from India, and Brunetti records material from Northern India (Simla).

Dryomyza melanderi Steyskal, nom. nov.

(Fig. 6)

Dryomyza maculipennis Melander, 1920, Entom. Soc. Am., Ann., 13: 311, *non* Macquart, 1850; Ouellet, 1941, Le Nat. Can., 68: 136.

I have examined a male specimen in the Museum of Comparative Zoology from Moscow Mountain, Idaho, labeled "paratype," from which the figure and the following notes are drawn: crossveins with strong brown spots; pterostigma brown; vein R_1 bare; prostigmatic bristle lacking; small prescutellars present; arista with numerous hairs approximately one-sixth as long as the arista; male terminalia



Details of *Dryomyza* Species

FIG. 7. *Dryomyza formosa* (Wied.), male terminalia

FIGS. 8–10. *D. puellaris*, sp. nov., male: 8, hind basitarsus; 9, ventral view of aedeagus and hypandrium and lateral view of aedeagus and aedeagal apodeme; 10, ventral and lateral views of epandrium

FIG. 11. *D. setosa* (Bigot), male terminalia

FIGS. 12–14. *D. simplex* Loew, male: 12, inner copulatory apparatus, lateral view; 13, same in lateroventral view; 14, terminalia

as sketched (Fig. 6), the surstyli similar to those of *D. flavcola*, but considerably longer.

Melander lists cotypes from Avon, Moscow, and Waha, Idaho, and Douglas, Alaska. I have seen a pair in the United States National Museum from Craig's Mountain, Idaho. Ouellet records the species from Montebello and Rigaud, Quebec.

Dryomyza puellaris Steyskal, sp. nov.

(Figs. 8–10)

Male.—Length of wing, 6.9–8.6 mm. (average of 10 specimens, 8.0 mm.).

General color tawny; the thorax with broad, somewhat brownish mid-dorsal and sublateral stripes. The following parts black: antennal segments 2 and 3, including arista; apical two-thirds of palpi; vallar ridge; apex of all femora and tibiae; all tarsi; abdominal tergites in great part (including a pair of sublateral spots on tergite 2; tergite 3, except anteromedially and on reflexed lateral parts; tergites 4 and 5, except lateral and posterior margins). Wings yellowish hyaline, a little deeper yellow anteriorly, veins brown to black. Hairs and bristles black, except those of lower sternopleura and squamae, which are yellowish, and those of venter and lower side of femora, which are black basally and whitish apically. Body and legs generally shining, but abdomen dorsally overlaid with grayish pruinosity.

Head very like that of *D. bergi* (Fig. 3), except that bristles are shorter, anterior parafrontal bristle much shorter than posterior, arista almost bare, third antennal segment narrower (1.5 times as long as wide), and palpi broader and extending a little beyond anteclypeus.

Thoracic chaetotaxy as follows: prosternum bare; 1 strong propleural; 1 weak prostigmatic (occasionally lacking); a few sternopleurals weakly distinguished from surrounding hairs; 1 humeral; 2 notopleurals; 1 sublateral; 1 supra-alar; 2 postalars; 2 dorsocentrals; 1 pair of strong prescutellar acrostichals; 4 scutellars.

Wing vein R_1 with numerous setae dorsally from apex to base of Rs; last section of M_1 slightly arcuate and very slightly converging toward R_5.

Middle tarsi with 3–5 medial posterior bristles. Fore and hind basitarsi with short apicoventral spur (Fig. 8). Hind femora below with soft pile nearly half as long as dorsoventral thickness of femora.

Terminalia as in Figures 9 and 10; surstyli clavate, smaller than anteroventral process of epandrium; aedeagus asymmetrical, with distinct tooth near middle of left side and a little pile posteriorly near tip.

Female.—Similar to male. Wing length 6.2–8.2 mm. (average of 5 specimens, 7.4 mm.). Fore and hind basitarsi simple. Hind femora with short hairs below. Sternopleura with 1 + 3 distinct bristles. Abdomen subshining, brown to piceous, with slender hairs and bristles.

Holotype (male), *allotype* (female), and *paratypes*[3] (5♂), Suifu (= Ipin or Suchow), Szechuen (= Szechwan), China; *paratypes:* 2♂, 1♀, Chengtu, Szechwan, China, altitude 5000 ft., Aug. 6–16, 1933; 2♂, 1♀, Summit Washan, Szechuen, China, 11,000 ft., July 26, 1925; 1♀, O-Er, 26 mi. N. Lifan, Szechwan, China, 10,800 ft., Aug. 16–25, 1933; 1♀, Mt. Omei, Szechuen, China, 11,000 ft., Aug. 20, 1921; all collected by D. C. Graham; in United States National Museum, except 2♂ from Suifu retained in my collection.

Dryomyza puellaris may be distinguished from related species as in the table. The specific name, in token of its more lively coloration, signifies "girlish," whereas the name of its relative *D. anilis* means "old-womanish."

Dryomyza senilis Zetterstedt

1838, Ins. Lapp.: 736; 1846, Dipt. Scand., 5: 2087; Czerny, 1930, *in* Lindner, Die Fliegen d. pal. Reg., 5 (fasc. 38a): 4; Séguy, Faune de France, 28: 88.

This form was described by Zetterstedt as a variety of *D. flaveola*. It is distinguished, according to Czerny and Séguy, by reddish yellow third antennal segment (not brownish), wholly black tarsi, non-infumated crossveins, and somewhat larger size (11 mm., instead of 5–9 mm.). It is known only from northern Europe. I have not been able to recognize the form in any of the material I have seen and, as stated under *D. flaveola*, strongly doubt that it is distinct.

Dryomyza setosa (Bigot), comb. nov.

(Fig. 11)

Odontomera setosa Bigot, 1886, Soc. Entom. France, Ann., for 1886: 386; Hendel, 1911, Deutsche Entom. Zeits. for 1911: 370.

[3] Although the International Commission on Zoological Nomenclature no longer recognizes paratypes (and says nothing about allotypes), they are of great practical systematic value and cannot be disregarded.

Neuroctena fumida Coquillett, 1901, U. S. Nat. Mus., Proc., 23: 616; Cresson, 1920, Am. Entom. Soc., Trans., 46: 33; Melander, 1920, Entom. Soc. Am., Ann., 13: 311.

The synonymy is by Hendel, based on examination of Bigot's type, although the new combination was not made.

This species is unique in having wing vein R_1 setose only part way from apex to origin of *Rs* and in the female by the short denticles instead of slender bristles at the apex of the abdomen. Further distinctions will be found in the key to species and in the male terminalia (Fig. 11).

I have seen Coquillett's type from Beulah, New Mexico, and specimens from Alaska (Glenn Allen; Seward; Valdez), British Columbia (Carbonate, Columbia River), Idaho (Moscow; Craig's Mt.), and Colorado (Grant). It is also reported by Melander from Montana and Washington.

Dryomyza simplex Loew

(Figs. 12–14)

1862, Mon. Dipt. No. Am., 1: 128; Smith, 1910, New Jersey St. Mus., Ann. Rep., for 1909: 796.

Neuroctena simplex (Loew) Hendel, 1911, Deutsche Entom. Zeits. for 1911: 370; Cresson, 1920, Am. Entom. Soc., Trans., 46: 33; Melander, 1920, Entom. Soc. Am., Ann., 13: 311; Johnson, 1925, Boston Soc. Nat. Hist., Occ. Papers, 7: 248; 1927, Biol. Surv. Mt. Desert Reg., pt. 1: 214; Leonard, 1928, Cornell Univ. Agric. Exp. Sta., Mem., 101: 845; Brown, 1934, Can. Entom., 76: 252.

Neuroctena ruthae Brimley, 1925, Entom. News, 36: 75; 1938, Ins. No. Carolina: 378. *New Synonym.*

The characters cited in the key and the very characteristic aedeagus (Figs. 12–14) will distinguish this form from its relatives.

I have seen material from Michigan (Grand Traverse, Mackinac, and Midland Counties), New York (Black Mt., Lake George; Ithaca; McLean; Otter Lake), Maine (Mt. Desert Id.), Connecticut (Lime Rock Station), Pennsylvania (Delaware Water Gap; Roxborough), North Carolina (Franklin, type of *N. ruthae*; Andrews Bald, Great Smoky Mts. Nat. Park), Tennessee (Clingman's Dome, Great Smoky Mts. Nat. Park), and Georgia (Black Rock Mt., Rabun Co.; Neel Gap). It has also been recorded in the literature from Ontario (Timagami), New Hampshire, Vermont, Massachusetts, and New Jersey. The distribution is thus typically Appalachian.

SPECIES IN SYNONYMY OR REFERRED TO OTHER GENERA

Dryomyza advena Wiedemann, 1830, Auss. Zweifl., 2: 449—South America. Lauxaniidae (v. Malloch, 1928, U. S. Nat. Mus., Proc., 73 [art. 23]: 1).

D. aristalis Coquillett, 1901, U. S. Nat. Mus., Proc., 23: 617—North America. Sciomyzidae.

D. convergens Walker, 1849, Cat. Dipt. Brit. Mus., 4: 983—Nova Scotia. Helomyzidae (v. Czerny, 1924, Abhandl. Zool.-Bot. Ges. Wien, 15: 129).

D. dayi Cresson. See *D. flaveola* (Fabr.).

D. dubia Macquart. Hendel (1912, Wien. Entom. Ztg., 31: 6) lists this name as published in "Dipt. exot., 2/3, p. 168" without locality and states that it is perhaps a Richardiid.

D. fuscicornis Meigen. See *D. flaveola* (Fabr.).

D. gigas Vollenhoven. See *D. formosa* (Wied.).

D. hannai Cole, 1921, California Acad. Sci., Proc., (4) 11: 174—Alaska. Helcomyzidae (v. Malloch, 1933, Dipt. Patagonia and So. Chile, pt. 6, fasc. 4: 326).

D. maculiceps Walker, 1858, Entom. Soc. London, Trans., n.s., 5: 319—Mexico. Type examination will be necessary to determine the status of this name.

D. maculipennis Macquart. See *D. formosa* (Wied.).

D. maculipennis Melander. See *D. melanderi* Steyskal.

D. mollis Haliday. See *D. flaveola* (Fabr.).

D. pallida Day. See *D. anilis* Fallén.

D. semicyanea Walker, 1858, Linn. Soc. London, Proc., 3: 109—Aru Islands. Doubtfully Dryomyzid, but type examination will be needed.

D. varia auctt., non Coquillett. See *Sciomyza* (Sciomyzidae).

D. vetula Fallén. See *D. flaveola* (Fabr.).

D. zawadskii Schummel. See *D. flaveola* (Fabr.).

Dryope communis Robineau-Desvoidy. See *Dryomyza flaveola* (Fabr.).

D. liturata Robineau-Desvoidy. See *Dryomyza anilis* Fallén.

Neuroctena fumida Coquillett. See *Dryomyza setosa* (Bigot).

N. ruthae Brimley. See *Dryomyza simplex* Lw.

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AN ECOLOGICAL STUDY OF THE WINTER BIRDS OF A 64-ACRE TRACT IN SOUTHERN MICHIGAN

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Introduction

The present paper is based on a study undertaken to determine populations and habitat relations of birds wintering in a 64-acre area of a 200-acre farm, the Newcomb Tract, owned by the University of Michigan (Fig. 1). The tract, which is representative of various animal habitats on farms in southern Michigan, is in the northwest part of Section 6, Webster Township (T. 1 S.; R. 5 E.), Washtenaw County, Michigan, and is approximately 12 miles northwest of the Ann Arbor campus of the University and 6 miles north of Dexter, Michigan.

Seven principal habitats were determined as follows (Fig. 1): Open Water, Marsh, Woods, Woodslope, Fencerow, Alpha Field, and Beta Field.

In order to establish the boundaries of the vegetation groups (habitats) and to be able to locate rather precisely any point on the area, the 64-acre tract was marked off in grid form (Pettingill, 1946, p. 200). The eastern border of the area is a mid-section line and was chosen as the north-south base line for determining the square-acre grid. The corners of these squares, except those in Newcomb Lake, were then marked by stakes driven into the ground, or by tags placed on trees, shrubs, or fences.

In taking a census of the bird population these grid lines were traversed systematically, and in effect the census taker passed within 105 feet of every point on the study area. This distance was considered sufficiently short to warrant accurate identification by sound, or by sight with the aid of seven-power binoculars. All censuses were begun at approximately the same time of day, early morning, and individual birds were plotted on maps in the field. Also, the time allotted to each census was constant.

The study period included three winter seasons of bird censusing:

WOODS
NEWCOMB LAKE
MARSH
WOOD SLOPE
MARSH
ALPHA FIELD
WOOD SLOPE
BETA FIELD
FENCEROW
FENCEROW
LEGEND
MAP OF THE
STUDY AREA
64 ACRE PORTION OF
THE NEWCOMB TRACT
SECTION 6 ; T 1 S ; R 5 E
WASHTENAW COUNTY, MICHIGAN

Fig. 1.

December 7, 1947, to February 22, 1948; December 11, 1948, to February 26, 1949; and December 4, 1949, to February 23, 1950. Twenty-five almost weekly censuses were taken on the area during winter, involving approximately 130 hours of field observation.

Acknowledgment is made to Drs. William H. Burt, Frank E. Eggleton, Frederick H. Test, and the late Carl D. LaRue for a critical reading of the thesis from which this paper is taken, and especially to Dr. Harry W. Hann for his many valuable suggestions in every phase of the study.

Description of Study Area

General Description

The study area is bordered on the north by Base Lake, and on the northwest by the Huron River (Fig. 1). The east boundary is a fence; the boundary on the south is a highway and that on the west is a farm fence originally intended for livestock. The west boundary fence on the upland part of the study area was moved during the study (dotted line on Fig. 1). The lake, river, and east boundary lines are property limits, but the west and south boundaries were arbitrarily chosen in order to keep the size of the area convenient and workable.

The Base Lake region is in the Thumb Upland Physiographic Province of the Lower Peninsula of Michigan, which lies in the glaciated plains part of the Central Lowlands Province of the United States (Scott, 1921, p. 21; Veatch, Wheeting, and Bauer, 1930, p. 1).

The elevation of the lowland part of the study area is 850 to 860 feet and of the upland 860 to 900 feet above sea level. The lower part contains a 6-acre lake, known here as Newcomb Lake.

The soils of the area consist of one organic soil, Rifle Peat, in the Marsh and low Woods, and two well-drained mineral soils of the upland part, Fox Sandy Loam and Bellefontaine Sandy Loam. All three types are of the Miami Family of the Gray-Brown Podzolic Soils. They are moderately acid on the higher ground and slightly acid to slightly alkaline on the lower areas (Veatch, Wheeting, and Bauer, 1930, pp. 16–17, 28, Soil Map).

The climate of this vicinity is characterized by fairly cold winters and warm summers, with a mean annual temperature of 47.5° F. Temperature and total precipitation data for the entire winter seasons

(recorded at the Willow Run Airport Weather Station approximately 27 miles southeast of the Newcomb Tract) were as follows:

Year	Mean, °F.	Extremes, °F.	Precipitation, inches
1947–48	24.13	1–43	5.29
1948–49	30.86	10–46	7.67
1949–50	30.13	9–55	11.69

Snow averages 37 inches per year but sometimes does not cover the ground all winter. The mean annual precipitation including melted snow is 31 inches.

The prevailing winds are westerly or southwesterly and are rarely of high velocity. Surrounding hills and woods lessen these winds on the study area, but those from the northeast sweep unhindered over the lower parts from the open expanse of Base Lake.

The Newcomb Tract was farmed until 1949, but only a little grazing and less crop planting were practiced from 1949 until the end of the present study period.

Fires as well as floods formerly swept through the marshy and low wooded areas. The last fire, April 10, 1941, burned over the entire Marsh, a part of the Woods, several spots in the Woodslope, and one half of the Alpha Field—a total of 20 acres. As a result of this, several fire breaks were plowed in May, 1941, and were kept cleared thereafter.

VEGETATION

The hardwood forest association formerly covering this part of southern Michigan consisted mainly of an oak-hickory subclimax with scatterings of beech, maple, elm, ash, basswood, sycamore, walnut, butternut, cottonwood, wild cherry, red cedar, and tulip tree, all locally abundant (Veatch, Wheeting, and Bauer, 1930, p. 2). Since the vegetation of this region is tending toward an ultimate mesophytic forest (Cowles, 1901, p. 7), the patches of beech and sugar maple in the early hardwood forest are considered to represent the climatic climax of this region. No part of the study area has reached this climax stage. The area does represent developmental stages approaching it, however, of which some apparently are natural and some due to the practices of man. The small Newcomb Lake in the northern half of the area studied shows the initial stages of the hydroseral plant succession represented in the lowland. Surrounding this

open water is the Marsh, a river-bottom or flood-plain, which is separated from the Woods, a stand of hardwood, by a shrubby ecotone. With its predominance of soft maples and a few beech seedlings, the Woods represents the most advanced sere of plant succession on the area.

The Woodslope, delineating the lowland from the upland, is a natural oak-hickory subclimax of the xeroseral succession. Adjacent to this stand is an area of the highest elevation, consisting of open fields and fencerows. These fencerows allow the woodland to move into and around the fields. The fields with their plantings, the driveway, and the fire breaks represent the artificially induced stages of the xerosere.

HABITATS

Open Water.—Base Lake and the Huron River are not considered a part of the study area, but, since certain aspects of bird behavior were influenced by their presence, they cannot be ignored completely. Base Lake is irregularly oval in shape, with its long axis lying east and west. It is approximately 1 mile in length and a half-mile in width. The study area lies south of the west end of the lake. The Huron River, which drains Base Lake to the southwest, varies in width and depth throughout the year, depending largely on the level of the water in the lake.

The 6-acre Newcomb Lake, within the area, is sheltered from the westerly and southwesterly winds by the Woodslope and from the west and north winds by the Woods.

The Marsh.—The approximately 12-acre Marsh is irregular in shape. Its vegetation is characterized by scattered poplar saplings at some of its edges and other high places, and by various shrubs scattered throughout most of the other parts. By far the bulk of the plant life is herbaceous, however, consisting of sedges, grasses, cattails, etc. About one half of the Marsh is open and is characterized by low vegetation. The other half is occupied by taller shrubs and scattered tree seedlings. The more common of the 204 species of plants observed on the area are given in Table I. Asterisks are used in the table to indicate the more abundant forms in each grouping (**** most abundant; — present). The nomenclature is from Fernald, 1950.

The Woods.—The northwest part of the study area supports 9

TABLE I

DISTRIBUTION OF COMMONER PLANTS ON THE STUDY AREA

Species	Marsh	Woods	Wood-slope	Fencerow	Alpha Field	Beta Field
Trees						
Acer rubrum	*	—	—			
Acer saccharinum	**	****				
Carya spp.			*			
Fraxinus nigra		***				
Juniperus virginiana		—	—	—	**	
Pinus sylvestris				—	***	
Populus grandidentata	***		**	*		
Prunus serotina		—	—	—	*	
Quercus spp.		*	***	**		
Sassafras albidum		—	—	***		
Ulmus americana	—	**	—	—	—	
Shrubs and woody vines						
Cornus racemosa	***	***	**	—	—	
Cornus stolonifera	*	**	—	—	—	
Lonicera tatarica			—	—	*	
Parthenocissus quinquefolia			—	**	—	
Potentilla fruticosa	**					
Rhus toxicodendron		*		—		
Rhus typhina			***	****	****	—
Rubus spp.			—	*	*	
Sambucus canadensis			*	—		
Vitis vulpina			—	***	—	
Herbaceous plants						
Apocynum androsaemifolium		*				
Carex sp.	****					
Equisetum sylvaticum		**				
Galium spp.			*			
Grasses	**	***	****	***	***	***
Melilotus spp.				*	—	
Phleum pratense		—		—	—	****
Potentilla recta				*	—	
Pteridium aquilinum			**			
Trifolium spp.					—	**
Typha latifolia	*					

acres of low, river-bottom woodland along the shore of a bay of Base Lake and its continuation into the Huron River. This rectangular, mostly deciduous Woods is part of a larger, similar stand on the opposite side of the bay and river. The Woods is a little over 200 feet wide at its narrowest place, 500 feet at its widest, and approximately 1000 feet long. To some extent birds utilize the two areas as though they were continuous.

The soil in the Woods was slightly alkaline in five widely separated spots that were sampled. It supports but sparse undergrowth except along its edges and along a few slightly higher ridges within. This undergrowth is primarily seedlings and shrubs. In general, the Woods consists of a canopy of maple, elm, and oak over an open interior, and the whole is surrounded by a dense, shrubby edge (Table I).

The trees were counted by species and size class according to diameter breast high (dbh) as follows: under 4 inches, 4 to 8 inches, 9 to 16 inches, 17 to 24 inches, 25 to 30 inches. There were several dead and dying elms along with one nearly dead sycamore in the 9- to 16-inch dbh class. This observation and a study of the distribution of species by age as indicated by size, lead to the conclusion that the elm, oak, basswood, and tulip trees of the older woodland type (Veatch, Wheeting, and Bauer, 1930, p. 2) are giving way to maple and ash with an indication of further establishment of beech.

The Woodslope.—Between the Marsh and the upland fields is the Woodslope, a very irregular, narrow strip of hardwood forest growing on the short, well-drained, gravelly bluff. The minimum elevation is about 854 feet, and the maximum approximately 880 feet. The area varies in width from about 50 to 200 feet, with an average of 60 feet, and contains about 9 acres. This wooded bluff continues to both east and west beyond the boundaries of the study area.

The Woodslope reaches out into the Marsh in a finger-like peninsula which is 3 to 5 feet above the surrounding marshland. The soil of this lower portion is slightly alkaline and not so well drained as the slightly acid soil of the more steeply sloped part.

The vegetation throughout the slope consists primarily of oaks and poplars, with frequent hickories on its upland edge. Occasional elm, basswood, butternut, ash, and wild black cherry, with willows

at the lowland edge, account for most of the remainder of the trees. In the more open areas where there are fewer trees, there are dense patches of sumac in the higher places, and gray dogwood and elderberry in the lower areas. Throughout the Woodslope there is a heavy herbaceous ground cover which is predominantly grass.

During the winter season bird movement seems to follow this wooded strip along both the river and lake shores. The area affords food and also shelter from the winds that sweep the more open areas.

The Fencerow.—This habitat varies in width from about 10 to 60 feet and has a total length of about six-tenths of a mile. Its total area is about 3 acres.

Its slightly acid, well-drained, sandy soil supports scattered sassafras, oak, and poplar trees predominantly, providing a narrow, open canopy. Shrubs and woody vines are more abundant than the trees and characterize the habitat, in contrast to the Woodslope (Table I).

It is especially the sumac and dense tangles of wild grape and Virginia creeper that make the Fencerow a place of concentration for numbers of birds throughout the year. In winter the numerous weed seeds, grapes, and other plant fruits provide food for birds; and the tangled mass of shrubs and vines provides shelter from the elements and certain predators. The bark-feeders also find a ready supply of food.

The Alpha Field.—The eastern half of the upland consists primarily of an L-shaped, 13-acre, abandoned field, the Alpha Field (Fig. 1). One half of this field was cultivated for crops until 1939, when it was abandoned for this use. Numerous shrubs and conifers were planted in and around the Alpha Field during the period of 1937–39.

Approximately one half of the soil of this field is Bellefontaine Sandy Loam, and the other half is Fox Sandy Loam. These two soils are similar in their productivity, and the natural vegetation in this field is reasonably uniform throughout (Table I). Grass is the most abundant form, with assorted herbs fewer in plants but greater in mass than the grass. Sumac is spreading in the field and is changing the open field characteristics rapidly. A few oak, elm, wild cherry, hickory, and maple seedlings have become established and suggest the future of this habitat if it is left alone.

The Beta Field.—The western half of the upland is an open, pentagonal field, the Beta Field. It was cultivated for crops through

1946 and then was used as a pasture for cattle until the spring of 1949. The Beta Field contained almost 15.5 acres until April, 1950, when the west boundary was moved eastward, reducing the size of the field to approximately 12.5 acres. Bird population densities as reported in this paper were calculated according to the actual size of the Beta Field at the time of the observation.

The soil of this habitat is predominantly Fox Sandy Loam, supporting an abundance of grass, especially timothy.

Birds of the Area

Forty species of birds were recorded on the study area in winter (Table II). In the region of the area 24 of these species were permanent residents, 3 were winter residents, 6 were summer residents, and 7 were transient visitants (Chapman, 1930, pp. 32–33). There was no nesting on the area in winter.

With the exception of hawks that utilized the area while in flight over it, only species that at some time alighted were considered.

The 7 species of birds most frequently observed on the area in winter in decreasing order of their average population per census were as follows:

Black-capped chickadee
Slate-colored junco
Blue jay
White-breasted nuthatch
American tree sparrow
American goldfinch
Ring-necked pheasant

The 7 species of birds most abundant in average number of individuals on the area in winter (averaged at least one individual seen per census taken), in decreasing order, were as follows:

Slate-colored junco
Black-capped chickadee
Purple finch
American tree sparrow
Cardinal
Blue jay
American goldfinch

Discussion

The winter bird populations of the area are analyzed here in regard to their make-up, fluctuations, and distribution. The populations of individual winters and the winter season in general are discussed with certain of the chief factors which may have had an effect upon these populations. It is apparent, however, that the

TABLE II

Population Density and Distribution of Birds in Winter

Species	Status	No. birds seen	Min.-max. /census taken	No. censuses seen	Ave. No. /census seen	Ave. No. /census taken	Ave. No./10 acres of habitat/census taken									Ave. No. /100 acres study area
							Open Water	Marsh	Woods	Wood-slope	Fence-row	Alpha Field	Beta Field	Sum	Ave.	
Black duck	PR	18	0–7	5	3.60	0.72	1.20							1.20	1.20	1.1
Cooper's hawk	PR	1	0–1	1	1.00	—						—			—	—
Red-tailed hawk	PR	2	0–1	2	1.00	—						—			—	—
Rough-legged hawk	Tr	1	0–1	1	1.00	—					—				—	—
Marsh hawk	PR	1	0–1	1	1.00	—							—		—	—
Sparrow hawk	PR	3	0–1	3	1.00	—					—				—	—
Ruffed grouse	PR	1	0–1	1	1.00	—		—							—	—
Bob-white	PR	1	0–1	1	1.00	—							—		—	—
Ring-necked pheasant	PR	28	0–7	11	2.54	1.12		—	—	—		—		0.96	—	1.7
Mourning dove	SR	1	0–1	1	1.00	—					—				—	—
Great horned owl	PR	2	0–1	2	1.00	—			—						—	—
Kingfisher	PR	8	0–1	8	1.00	—	—	—	—	—					—	—
Flicker	PR	7	0–2	4	1.75	—			—	—	—				—	—
Hairy woodpecker	PR	9	0–2	8	1.12	—			—	—	—				—	0.6
Downy woodpecker	PR	5	0–2	4	1.25	—				—					—	—
Horned lark	PR	16	0–8	5	3.20	0.64							—		—	1.0
Blue jay	PR	76	0–10	21	3.62	3.04		—	1.38	1.16	1.20			4.07	1.02	4.7
Crow	PR	34	0–5	8	4.25	1.36			1.07	—		—		1.38	—	2.1
Chickadee	PR	286	0–19	25	11.44	11.44		2.80	2.31	5.44	3.73			14.29	3.57	17.6
Titmouse	PR	11	0–2	8	1.38	—			—	—	—				—	0.7
White-breasted nuthatch	PR	27	0–3	19	1.42	1.08			0.76	—	—			1.29	—	1.7
Brown creeper	Tr	5	0–3	3	1.67	—			—						—	—
Winter wren	Tr	1	0–1	1	1.00	—		—							—	—
Catbird	SR	1	0–1	1	1.00	—				—					—	—
Bluebird	SR	1	0–1	1	1.00	—				—					—	—

Golden-crowned kinglet	Tr	10	0–3	4	2.50	—		—	—						—	0.6
Starling	PR	16	0–3	7	2.29	0.64		—	—		1.6	—		1.74	—	1.0
House sparrow	PR	27	0–18	4	6.75	1.08					1.2		—	1.68	0.84	1.7
E. meadowlark	SR	3	0–2	2	1.50	—						—	—		—	—
Red-wing	SR	4	0–2	1	4.00	—		—				—			—	—
Cardinal	PR	91	1–9	25	3.64	3.64		—	—	1.33	6.13			8.03	2.01	5.7
Purple finch	WR	246	0–200	6	41.00	9.84		6.67	—	1.96				8.89	2.93	15.4
Redpoll	Tr	8	0–8	1	8.00	—					1.07			1.07	1.07	—
Pine siskin	Tr	2	0–1	1	2.00	—				—		—			—	—
Goldfinch	PR	57	0–13	16	3.57	2.28		—	—	—	4.00	—		4.98	1.00	3.6
Towhee	SR	2	0–2	1	1.00	—				—		—			—	—
Junco	WR	325	0–26	23	14.13	13.00		—	—	5.60	20.67	—	1.00	27.75	4.62	20.3
Tree sparrow	WR	182	0–21	17	1.36	9.28		6.73		1.33				8.07	4.02	14.5
White-throated sparrow	Tr	1	0–1	1	1.00	—		—							—	—
Song sparrow	PR	6	0–2	5	1.20	—		—			—				—	—
Totals: 40		1526		25	144.18	63.00	1.40	14.60	18.10	18.55	40.66	1.39	2.36	97.06	26.96	96.9
Minus purple finch flock		1326				53.04										81.54

fluctuations and distribution of the bird populations are to be considered more as functions of the ecosystem involving them than the result of any one or a combination of these chief factors.

Bird populations fluctuated in species and numbers during the winter, and these fluctuations had *daily*, *monthly*, and *yearly* aspects. Many of the *daily* fluctuations were accounted for by wandering flocks of resident species (chickadee, purple finch, junco). Some species (downy woodpecker, tufted titmouse, white-breasted nuthatch) apparently had daily schedules of feeding near roosting places in the morning, then gradually moved off the area and returned later in the day. Censuses were taken during the same period each day in order to minimize any statistical error which otherwise would result from this type of daily fluctuation. *Monthly* variations (Fig. 2) in populations were due in part to the presence and absence of certain species during the different months as well as to the presence and absence of individuals of the same group of species (Tables III–V). In early winter the appearance of transients (brown creeper, winter wren, golden-crowned kinglet) and unusually late departures of summer residents (catbird) increased the December population. Early arrival in the spring (late winter) of summer residents (mourning dove, bluebird, meadowlark, red-wing) and transients (redpoll, pine siskin) resulted in larger populations in February than in January. Certain "half-hardy" species (those species whose wintering range was south of the study area during unfavorable winters—Trautman, 1940, p. 115) (cardinal, song sparrow) increased or decreased in numbers throughout the winter months, depending on the climatic changes. *Yearly* fluctuations (Fig. 3) resulted from the presence of species one year and not another, and from the variation in numbers of individuals of those species that were present each year (Tables III–V). The winter resident population was more or less constant during any one winter, however. The over-all fluctuations were due primarily to the interplay of the appearance of more species or larger numbers of individuals one day, month, or year and their absence during others.

The data from this study indicate that chief among the factors influencing population fluctuations and distribution of birds on the area, and approximately in the decreasing order of effect, are the following: *temperature*, *food*, *precipitation*, *cover*, *characteristic local movements* of the birds themselves, and other biotic factors such as

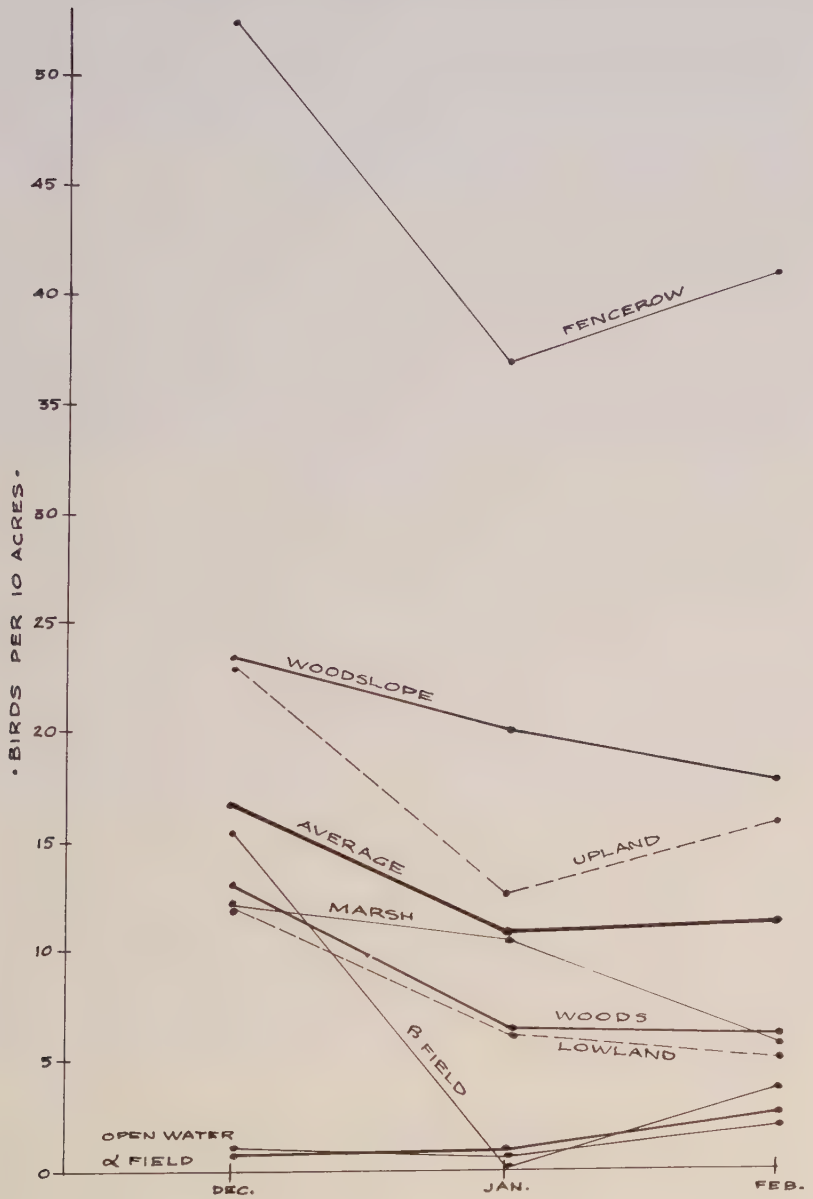

FIG. 2. Average monthly population density of birds by habitat in winter, 1947–50.

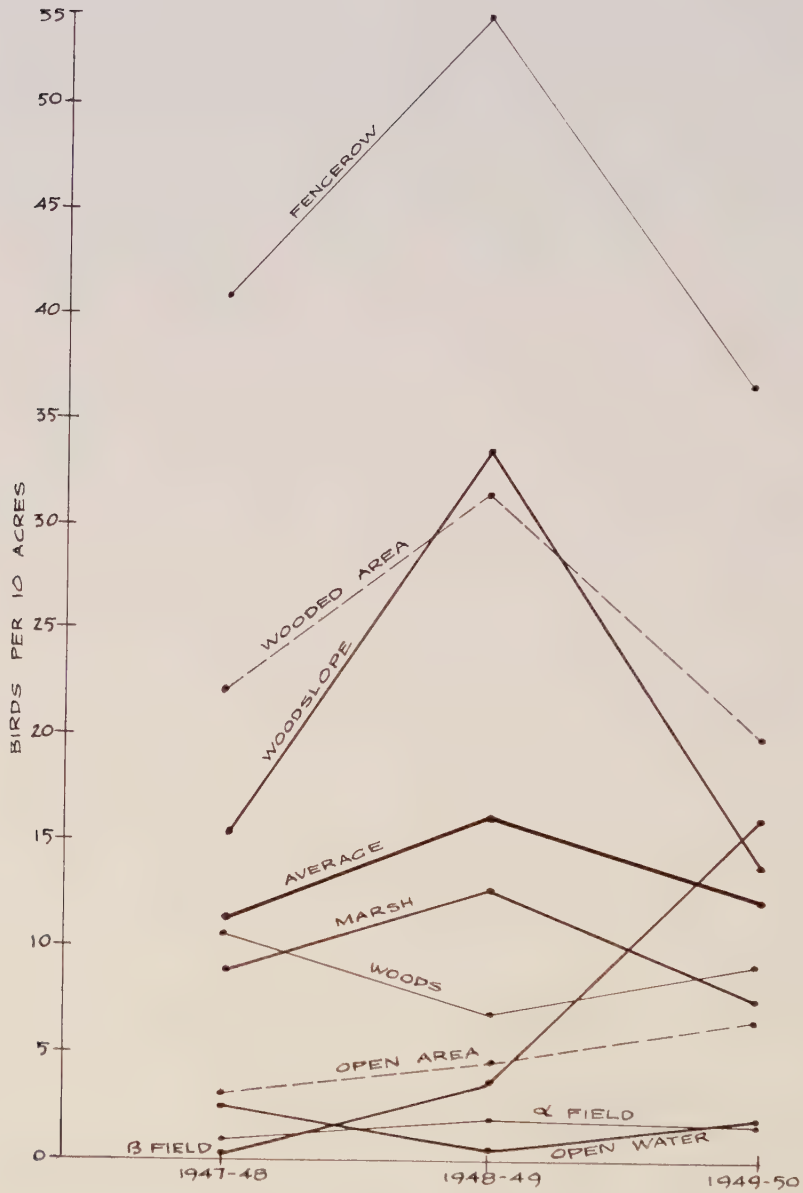

Fig. 3. Average population density of birds by habitat and winter.

reproductive success of the preceding season and *predatism*. Regional *temperature* variations probably determined the presence or absence of certain species. Some "half-hardy" species and/or individuals apparently moved to more favorable areas during a cold fall and early winter season, or whenever the temperature dropped close to their limit of tolerance. Some species invaded the area from farther north when local temperatures were not so close to their limits of tolerance as in areas from which they came (Kendeigh, 1934, pp. 345–346).

The abundance of *food* and its location influenced the population and its distribution, especially as combined factors with *precipitation* (snow) and *cover* (protection from wind). The amount of food produced on the area each year was not so regulatory on population fluctuation and distribution of birds on the area as was its availability in respect to snow cover. Within the over-all yearly fluctuations of the total populations of all species in winter there was a definite pattern of distribution of birds, and this was rather consistent from year to year. Because of greater availability of food in the wooded habitats (Woods, Woodslope, Fencerow) these areas had a greater population density each winter than did the open habitats and averaged 4.3 times as great for the three-winter period (Fig. 3). The year of greatest difference (1947–48) was the coldest, least "open" winter.

Though the population density of the wooded areas was consistently greater than that of the open areas, as winter progressed the average population of the lowland (Woods, Marsh) decreased and that of the Woodslope and upland habitats (Alpha and Beta Fields, Fencerow) increased (Fig. 2). The lowland areas, especially the Marsh, provided little food for most of the wintering species. What little there was either disappeared early in the season or was covered by snow, with the exception of January, 1950, when the Marsh was more open. The snow cover was dependent on the winds as well as on the amount of precipitation (snow). The winter prevailing winds were from the south and southwest, and the lowland areas were somewhat sheltered by the Woodslope. Occasional northeast winds often drifted snow into the unprotected Marsh where it commonly remained long after melting had occurred in the upland. Winds from the south and southwest over the upland area were not only somewhat warmer than those from the northeast, but they kept clear of snow the seed-bearing portions of many plants in the Fields.

TABLE III

Average Distribution of Birds by Species and Habitat* in Winter, 1947–48

Species	December								January								February							
	W	M	OW	Ws	Fr	BF	AF	Total	W	M	OW	Ws	Fr	BF	AF	Total	W	M	OW	Ws	Fr	BF	AF	Total
Black duck																			9					9
Cooper's hawk															1	1								
Red-tailed hawk																								
Rough-legged hawk																								
Marsh hawk					1			1																
Sparrow hawk		1						1																
Ruffed grouse																								
Bob-white				1				1																
Ring-necked pheasant																								
Mourning dove																								
Great horned owl	1							1																
Kingfisher			1					1			1					1								
Flicker	1			2	1			4				1				1								
Hairy woodpecker																								
Downy woodpecker	3							3	2							2								
Horned lark																								
Blue jay				1	1			2		3		2				5	1	1		5	1			8
Crow																	5							5
Chickadee	8	24		13				45	15	8		8				31	8	8		4	3			23
Titmouse																	1			1				2
White-breasted nuthatch	3							3				1				1	2							2
Brown Creeper																								
Winter wren		1						1																
Catbird																								
Bluebird																								
Golden-crowned kinglet		5						5																

Starling																									
House sparrow																									
E. meadowlark																									
Red-wing																									
Cardinal				9	7			16				2	4			6		1		2	4			7	
Purple finch	6							6		200						200									
Redpoll																									
Pine siskin																									
Goldfinch		1						1	5						4	9	1							1	
Towhee																									
Junco					16			16		7		21	22			50	2			18	24		3	49	
Tree sparrow										5						5		1		1				2	
White-throated sparrow										1						1									
Song sparrow																									
Totals	22	32	1	26	26			107	22	224	1	35	26		5	313	20	11	9	31	32		3	106	

* W, Woods; M, Marsh; OW, Open Water; Ws, Woodslope; Fr, Fencerow; AF, Alpha Field; BF, Beta Field.

TABLE IV

Average Distribution of Birds by Species and Habitat* in Winter, 1948–49

Species	December								January								February							
	W	M	OW	Ws	Fr	BF	AF	Total	W	M	OW	Ws	Fr	BF	AF	Total	W	M	OW	Ws	Fr	BF	AF	Total
Black duck																								
Cooper's hawk																								
Red-tailed hawk																								
Rough-legged hawk																								
Marsh hawk																								
Sparrow hawk					1			1					1			1								
Ruffed grouse																								
Bob-white																								
Ring-necked pheasant		1						1															7	7
Mourning dove																								
Great horned owl																								
Kingfisher		1						1										1						1
Flicker																					1			1
Hairy woodpecker									1							1	1			1	1			3
Downy woodpecker				1				1	3							3				2	1			3
Horned lark																						11		11
Blue jay	1							1	1	1		1				3	1			1				2
Crow																	15			5				20
Chickadee	4	3		11				18	2	3		10	2			17		8		13	2			23
Titmouse	2							2	1				1			2				1				1
White-breasted nuthatch	1			1				2	3							3	1			4	1			6
Brown creeper																								
Winter wren																								
Catbird																								
Bluebird																								
Golden-crowned kinglet																				1				1

Starling													1			1	1			3		2	6
House sparrow													4			4				2			2
E. meadowlark																						2	2
Red-wing																		2				2	4
Cardinal				2	1			3				1	3			4			3	7			10
Purple finch												33				33							
Redpoll																				8			8
Pine siskin																			1			1	2
Goldfinch							2	2					8			8				13		2	15
Towhee												1				1						1	1
Junco				18	19			37				21	11			32			26	13	26		65
Tree sparrow		14		9				23		27		2				29		32	18				50
White-throated sparrow																							
Song sparrow		1						1		1						1		1					1
Totals	8	20		42	21		2	93	11	32		69	31			143	19	44	76	52	37	17	245

* W, Woods; M, Marsh; OW, Open Water; Ws, Woodslope; Fr, Fencerow; AF, Alpha Field; BF, Beta Field.

TABLE V

Average Distribution of Birds by Species and Habitat* in Winter, 1949–50

Species	December								January								February							
	W	M	OW	Ws	Fr	BF	AF	Total	W	M	OW	Ws	Fr	BF	AF	Total	W	M	OW	Ws	Fr	BF	AF	Total
Black duck			5					5			2					2			2					2
Cooper's hawk							1	1									1							1
Red-tailed hawk													1			1								
Rough-legged hawk														1		1								
Marsh hawk														1		1								
Sparrow hawk																								
Ruffed grouse																								
Bob-white																								
Ring-necked pheasant	4	5						9		4					2	6							1	1
Mourning dove																							4	4
Great horned owl	1							1													1			1
Kingfisher	3							3																
Flicker												1				1								
Hairy woodpecker	1							1	3							3				1				1
Downy woodpecker	1			2				3				2				2	2	1		1				4
Horned lark														3		3						2		2
Blue jay	19	4		10	6			39	7			6				13	1	1			1			3
Crow									2							2	4						3	7
Chickadee	13	11		14	5			43	2	10		33				45		9		16	16			41
Titmouse				2				2									2							2
White-breasted nuthatch	3			1				4	2			1				3	2			1				3
Brown creeper	5							5																
Winter wren																								
Catbird				1				1																
Bluebird																								
Golden-crowned kinglet	5							5																

Starling					2			2					3			3		1			3			4
House sparrow						18		18					3			3								
E. meadowlark																						1		1
Red-wing																								
Cardinal	6	8		7	10			31				2	7			9				2	3			5
Purple finch				2				2				3				3				2				2
Redpoll																								
Pine siskin																								
Goldfinch					5		6	11				1	4			5				4			1	5
Towhee																								
Junco					24	4		28		2		8	22			32				14	4			18
Tree sparrow										46						46								
White-throated sparrow																								
Song sparrow		2			1			3																
Totals	65	30	5	39	53	22	7	217	16	62	2	57	40	4	2	183	12	12	2	41	28	3	9	107

* W, Woods; M, Marsh; OW, Open Water; Ws, Woodslope; Fr, Fencerow; AF, Alpha Field; BF, Beta Field.

The Fencerow served as excellent cover as a snow fence, leaving the ground almost clear of snow on its lee sides.

Characteristic local movements of certain species in their search for food as a result of these factors (precipitation, cover, wind) are illustrated later in the discussion by data concerning the black-capped chickadee. The winter populations of species which nested on the area were affected by their *reproductive success* during the preceding nesting season, as in the case of the downy woodpecker and black-capped chickadee. *Predatism* and other mortality-producing factors directly affected the population by reducing it, further contributing to the over-all fluctuations.

In this discussion all population figures and the comparisons involving them exclude a large flock of 200 purple finches observed on January 5, 1948, because of its distorting effect on the total picture of the winter bird population. This seems advisable when dealing with total populations of a size comparable to that of a single flock present but momentarily on the area. The purple finch data are included in some of the charts and tables for comparison, however.

The following tabulation gives the population density of the area (64 acres) in numbers of birds seen per 10 acres per census, by month and year of the study. Average population densities are given both for restricted habitats (where seen) and for the entire area.

	1947–48		1948–49		1949–50	
Months	Restricted habitats	Study area	Restricted habitats	Study area	Restricted habitats	Study area
December	16.8	12.0	29.0	20.7	18.4	18.4
January	14.6	12.5	18.3	10.4	9.8	9.8
February	10.6	9.1	20.0	17.1	8.4	8.4
Average	13.8	11.2	22.4	16.1	12.2	12.2

Winter, 1947–48.—The population density of birds on the area during this season was the least of the three winters (Fig. 3), and there was much less over-all fluctuation in numbers and distribution from month to month than during either of the other two winters. This was the coldest, driest, and least "open" winter of the study, and it followed the coldest November of the three years. The bird population was made up of the hardiest species and individuals represented on the area in winter. No summer residents were observed; i.e., none remained in December or arrived early in Febru-

ary. With the exception of the large flock of purple finches, there was less invasion of the area by winter residents from farther north. The population density of the wooded areas as a whole (Woodslope, Woods, Fencerow) was approximately six times that of the open area, where the food was less available (Fig. 3).

Winter, 1948–49.—This three-month period was the warmest and most "open" winter of the three-year period and yielded the largest bird population. This was the winter also of greatest fluctuation in numbers and distribution of birds on the area. During the other two winters the populations in some habitats increased, and in others decreased, from month to month through the season; but during 1948–49 there was instead a marked over-all decrease from December to January, and a slight increase from January to February. Although November, 1948, was the warmest of the three years, it had the most snow; but there was less than usual later. All summer resident species had left the area by December; but the invasion of the area by a large number of winter residents (especially juncos and tree sparrows) during December resulted in the high population of this month. One summer resident arrived on the area in January (towhee), but the low numbers of winter residents from other areas caused the over-all population decrease from that of December. Three other summer residents arrived in February (bluebird, meadowlark, red-wing). These summer residents and another invasion by a large number of winter residents (especially juncos and tree sparrows) in February apparently resulted in the population increase from January to February. The presence of some "half-hardy" species and the early return of others also added to this pattern of population decrease followed by increase; a song sparrow was seen throughout the season, and cardinals increased in number over 150 per cent (3–10) in February. The wooded areas contained about five times the population density of birds found in the open areas as against six times the winter before (Fig. 3). In general, there was less snow cover and less drifting in the Marsh and upland areas, especially in January, than there was in the winter of 1947–48.

Winter, 1949–50.—This winter period was almost as warm as the previous winter and had the next-largest bird population of the three winters (Fig. 3). There was a marked decrease in average numbers of birds from December to January, and a further decrease from January to February. There was less shifting in distribution than there

was in 1948–49 but considerably more than in 1947–48. The preceding November was almost as warm as November, 1948, and it had less snow. One summer resident species lingered on the area in December (catbird), and two arrived in February (mourning dove, meadowlark). "Half-hardy" species decreased markedly in number (cardinal) or disappeared entirely (song sparrow) in late December. Fewer individuals of winter resident species (purple finch, junco, tree sparrow) invaded the area than during either of the other winters of the study (Tables III–V). The occurrence of fewer transients in January and February also accounted for this decrease in the bird population on the area. The mildness of weather conditions during the usual period of invasion of the area by winter residents apparently was widespread enough not to force these birds this far south that year. Also, the severity of those conditions in late winter prevented transients from arriving during that period. In the wooded areas there was only about twice the average population density of birds that was found in the open areas (Fig. 3); and this smaller difference between the populations of the wooded and open areas was due to the fact that the birds in the Marsh habitat increased in number considerably in January, and the population of the Woods decreased by even a greater amount.

The winter season.—In winter the bird population on the study area was less dynamic than it was during any other season of the year. With few exceptions, the fall migrations had ended and the spring migrations had not yet begun. All the summer resident species, except a single catbird straggler (December 12, 1949), had left the area before the winter season began. The four other summer resident species recorded in winter apparently arrived from one to two months in advance of their usual spring arrival time (bluebird—February 26, 1949; meadowlark—January 28, 1950, and February 26, 1949; red-wing February 26, 1949; towhee January 22, 1949, and February 6, 1949). Of these summer residents seen in winter, those whose sex could be determined by their plumage (bluebird, red-wing, towhee) were males, and the remainder (catbird, meadowlark) were singing individuals, hence presumably males. Records of males being the first arrivals in spring are common in the ornithological literature (bluebird—Bent, 1949, p. 235; oven-bird—Hann, 1937, p. 209; red-wing—Allen, 1914, p. 78; towhee—Forbush and May, 1939, p. 503). According to Trautman (1940, p. 116), males

also predominate among those species the majority of whose individual members usually winter somewhat farther south.

The black-capped chickadee was the most abundant species in winter and serves as an example of those species which moved about considerably over the area in search of food. The chickadees wandered slowly through the area in loose flocks, apparently returning and repeating the process, but not necessarily following the same routes. Observations regarding the looseness of flock organization among chickadees and their inconsistency in direction and rate of movements coincide with the findings of Odum (1942, pp. 505, 507, 509) in a study of this species in winter on a natural wooded upland area in New York. Odum (1942, p. 530) estimated that the average range of a flock was 36 acres. The wandering of chickadees was discussed also by Butts (1931, pp. 4, 10, 12) in a study of the species in a wooded bottomland area near Ithaca, New York. He stated that each flock had a definite range—about 40 acres—and that definite routes were not followed. On the Newcomb Tract and vicinity it was observed that the area covered by these flocks was smaller in early winter than later in the season. The area covered early in the season was approximately 30 acres, and that in late winter about 45 acres. The ranges were considerably different in different winters, however, and the data are not sufficient to present a more detailed account.

The average winter chickadee population on the Newcomb Tract is compared here with those determined elsewhere in winter by various investigators:

Reference	Habitat, size, locality	Chickadees per 100 acres
Forbes and Gross (1923)	58 acres open wooded area in northern Illinois	10.3
Butts (1931)	80 acres bottomland woods in south-central New York	ca. 38
Butts (1931)	1 square mile scattered woods in south-central New York	20
Van Deventer (1936)	1700 acres forest, swamp, etc., in western New York	ca. 20
Odum (1942)	375 acres natural upland wooded area in east-central New York	ca. 15
Present study	33 acres restricted habitat where seen	35.7
Present study	64 acres total study area (all habitats)	17.6

The 17.6 chickadees per 100 acres on the Newcomb Tract study area as a whole is fairly consistent with the figures of larger, more varied areas; and the 35.7 chickadees per 100 acres of habitats where seen on the Newcomb Tract is comparable to the findings of Butts (ca. 38) on a restricted habitat basis.

In the following tabulation the total average population density of all species of birds on the area in winter, 130 birds per 100 acres, is compared with densities determined elsewhere in winter by various investigators (the asterisk indicates figures changed to read in birds per 100 acres).

Reference	Habitat, size, locality	Birds per 100 acres
Forbes and Gross (1923)	58 acres open wooded area in northern Illinois	66*
Van Deventer (1936)	1700 acres forest, swamp, etc., in western New York	66*
Kendeigh (1944)	430 acres (total) various habitats in northern Ohio	150
	357 acres of forest in northern Ohio	82
	55 acres deciduous forest in east-central Illinois	151
George (unpublished thesis)	171 acres general farmland in southern Michigan (1947–50)	133 (ave.)
Present study	64 acres total study area (all habitats) (1947–50)	130 (ave.)

Of particular interest in the above is the similarity of population densities between similar study areas about 25 miles apart and for the same winter season (George, unpublished thesis, and present study).

Summary

1. A 64-acre part of a southern Michigan farm was studied in an attempt to determine populations and habitat relations of birds found there during three winters: 1947–48, 1948–49, and 1949–50. The study area is approximately 12 miles northwest of the Ann Arbor campus of the University of Michigan.

2. The study area was surveyed for physical conditions which included physiography, soils, and geology. The vegetation was surveyed and the area was divided and mapped into seven habitats as follows: Open Water, Marsh, Woods, Woodslope, Fencerow, Alpha Field, and Beta Field.

3. Bird populations were determined by use of a direct-observa-

tion and absolute-abundance method. Twenty-five almost weekly censuses were taken, including 130 hours of field observation. Maps showing habitats and a square-acre grid, the corners of which were marked in the field, were employed in the census taking.

4. Among the chief factors influencing the daily, monthly, and yearly fluctuations and distribution of birds in winter were: temperature, food, precipitation, cover, characteristic local movements of birds, reproduction, and predator pressure (approximately in decreasing order of effect).

5. Temperature probably influenced the presence of species to a greater extent than it influenced their distribution.

6. Precipitation, particularly snow and its piling up by the winds, had a greater effect on distribution of birds than did temperature. Food in certain areas was made unavailable by the snow cover.

7. The average population density of all species of birds seen on the study area in winter per census was 13.0 birds per 10 acres or 130 birds per 100 acres.

8. The largest average winter population density (15.8 birds per 10 acres) and the greatest amount of fluctuation in numbers and distribution were observed during the warmest, most "open" winter (1948–49).

9. The smallest average winter population density (11.2 birds per 10 acres) and the least amount of fluctuation in numbers and distribution of birds from month to month were observed during the coldest, driest, least "open" winter (1947–48).

10. The average population density of the three-year period decreased markedly from December (16.9 birds per 10 acres) to January (10.7 birds per 10 acres), and increased slightly from January through February (11.3 birds per 10 acres), but during two years there was a slight decrease from January through February.

11. There was a higher average population density of birds in the characteristically wooded areas throughout the season than in the open areas (4.3 times as high).

12. Some fluctuations in the population were due to the wandering on and off the area by flocks and individuals of resident species, and to irregular invasions by others, both resulting from a search for food.

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GEOLOGY

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A PLEURACANTH SHARK SPINE FROM THE EARLY PENNSYLVANIAN, SAGINAW FORMATION, OF MICHIGAN

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Introduction

Professor C. A. Arnold, Curator of Paleobotany in the Museum of Paleontology, University of Michigan, on one of his several visits to the St. Charles–Garfield mine during the period 1929–39, found the cephalic spine to be described. It is, to the best of my knowledge, the first fossil vertebrate to be recorded from the Pennsylvanian rocks of this state. I am indebted to Professor Arnold, and to Professor C. W. Hibbard, of the Museum of Paleontology, for permission to prepare and study the specimen.

Taxonomy

This specimen of an extinct fossil fish is classified as follows:

Class Chondrichthyes
Subclass Elasmobranchii
Order Pleuracanthodii
Family Pleuracanthidae
Genus *Pleuracanthus* Agassiz, 1837
Pleuracanthus cf. *P. arcuatus* Newberry, 1856

(See Fig. 1)

P. arcuatus, Newberry, 1856, Acad. Nat. Sci. Phila., Proc.: 100.
Orthacanthus arcuatus, Newberry, 1873, Geol. Surv. Ohio, Rep., Vol. 1—Geol. and Paleont., pt. 2—Paleont., p. 332, and pl. 40, fig. 4.
P. arcuatus, Woodward, 1899, Cat. Foss. Fishes Brit. Mus., pt. 1: 8.

Locality and Horizon

The specimen was found in a piece of black shale matrix on the dump of what was called the St. Charles-Garfield mine (Arnold, 1949,

Map 2, locality 11) at the town of Eastwood (sometimes called Garfield) about 3 miles north of St. Charles, in the NW. corner, Sec. 21, T. 11 N., R. 3 E., Saginaw County, Michigan.

No doubt the specimen is from the Saginaw formation, and, judging from the associated fossil plants, it is probably from just above the Saginaw coal horizon (Arnold, personal communication, February, 1956)—that is, the "lower" floral zone of Arnold (1949, pp. 149–150).

FIG. 1. *Pleuracanthus* cf. *P. arcuatus* Newberry. Cephalic spine. Univ. Mich. Mus. Pal. No. 33463. ca. × ½. *a*, Distal part restored from natural cast to show hooks, right side. *b*, Right side, dotted straight line for measure of posteriad curvature *c*, Posterior view. *d*, *e*, Cross sections through levels shown by dotted lines.

Description

(See Fig. 1)

This cephalic spine, University of Michigan Museum of Paleontology No. 33463, from a large pleuracanth shark is incomplete. It lacks a small part of the distal end and a larger part of the base. The remaining part may be described as follows: gently curved posteriad; slightly compressed anteroposteriorly, therefore oval in cross section; posterior surface flattened and bearing a median longitudinal groove; surface finely striated but not beaded; a central longitudinal cavity; distally bearing two series of acuminate, posteriorly deflected hooks, one series along each edge of the posterior flattened face; hooks closely set but bases not confluent.

Measurements (in millimeters)

Maximum anteroposterior diameter	14.0
Maximum transverse diameter	17.5
Actual length of specimen	187.0
Estimated total length of specimen when complete	215.0
Number of hooks per millimeter	0.45 to 0.50

The hooks on the left side of the spine are broken away, but their bases remain clearly marked.

The specimen is slightly larger than the type of *P. arcuatus* Newberry, 1856, but otherwise most closely resembles that species from Pennsylvanian strata at the Linton, Ohio, locality. It also bears a close resemblance to *Pleuracanthus bohemicus* (Fritsch, 1877) from the lower Permian of Czechoslovakia, particularly because of the presence of a posterior median longitudinal groove in both.

Age of the Specimen

Pleuracanth remains have been found in Europe and North America in strata ranging from Mississippian to Permian. They have been reported from the Triassic of Australia and with question from the Triassic of Europe. The type of *P. arcuatus* and similar spines are known from coal-bearing strata at Linton, Ohio, and Mazon Creek, Illinois, both localities of mid-Pennsylvanian age. The age of this spine can best be determined from the associated flora, however. Arnold (1949, p. 140) records eight genera including twelve species of fossil plants from the St. Charles–Garfield mine dump. These in-

clude three species, *Neuropteris Schlehani*, *N. saginawensis* and *Aulacotheca Campbelli*, which he considers (p. 149) characteristic of the Saginaw coal horizon or "lower" flora of the Saginaw formation. He assigns that flora on paleobotanic evidence (pp. 153, 155) to the late Lee (early Pennsylvanian). This is in slight disagreement with Moore *et al.* (1944, pl. 1), who considered the basal part of the Saginaw formation to be somewhat younger (early Kanawha-early Pennsylvanian).

Significance of the Specimen

The occurrence of this extinct fish is noteworthy in several respects.

1. From a provincial point of view, it is the first fossil vertebrate reported from the Pennsylvanian of Michigan. Evidently Pennsylvanian depositional environments in this state at least partly favored the preservation of vertebrate remains. The St. Charles–Garfield mine, reached by a deep shaft, was abandoned in 1942, and the shale on the dump weathers rapidly, so it is unlikely that more vertebrate fossils will be found there, either on the surface or at depth. The Michigan coal measures are not entirely barren of vertebrates, however, and further search elsewhere may provide additional specimens.

2. Whether one accepts the age determination of Arnold or Moore, this specimen of *P. arcuatus* is older than any similar pleuracanths heretofore reported from this part of the United States. It is definitely older than the pleuracanths from the Linton or Mazon Creek localities.

3. The specimen slightly extends the known geographic range of the genus.

4. As an index to the Pennsylvanian environment of deposition in Michigan, the pleuracanths are thought to have been bottom-dwelling freshwater fishes (Dollo, 1906). There is both stratigraphic and morphologic evidence for this conclusion.

Over forty species of pleuracanths have been reported. Complete specimens are rare, but isolated spines (also assigned to several form-genera such as *Orthacanthus* Agassiz, 1843, and *Xenacanthus* Beyrich, 1848) and teeth (known as *Diplodus* Agassiz, 1843) are relatively common. Specimens are reported from England, Scotland, Wales, France, Bohemia, Silesia, Russia, New South Wales, Nova Scotia (the Joggins locality), Ohio (Linton), Illinois (Mazon Creek), Indiana, Iowa, Nebraska, and Texas. All were found either in the coal

measures of those regions or in other deposits of continental nature. They have been found in association with land plants, presumed freshwater invertebrates, and amphibians and reptiles of undoubted freshwater or terrestrial origin. None have been reported in direct association with a marine or even a convincingly brackish water assemblage. Although most living sharks are marine forms, some occur in fresh water. One species, normally marine, has been found far up the rivers of India, along the Tigris River near Baghdad 300 miles from the Persian Gulf, and in a lake in the Fiji Islands. Another, found in Lake Nicaragua and its outlet, the Rio San Juan, is only known to occur in fresh water.

From the morphologic point of view, the pleuracanths represent a divergent evolutionary branch whose peculiar structure removes the necessity for ascribing to them, *a priori*, the normal habitat preferences and adaptations of their nearest living relatives, the sharks.

The anterior part of the body, particularly the skull, was slightly flattened dorsoventrally, a condition found in many modern bottom-dwelling fishes. The fringed pectoral fins were constructed on the primitive, archipterygial plan. The posterior end of the vertebral axis was slightly upturned; the heterocercal form. A dorsal fin, beginning just behind the head, continued along the back to the tip of the long, slender tail, then extended forward along the ventral surface to the approximate position of the vent.

In restorations the upper and lower portions of the caudal fin appear to have been about equally developed and the fin outwardly symmetrical. This condition, called gephyrocercal or secondarily diphycercal, superficially resembles a tail form found in some slow-swimming, bottom-dwelling modern fishes and could be interpreted as an adaptation for benthal existence. The heterocercal tail of modern sharks serves to lift the posterior part of the body, directing the impulse of the tail partly in a downward direction (Breder, 1926, pp. 224–225), and thus tending to impel the body toward the bottom. This is so because the much longer and more flexible part of the caudal fin hangs down from the upturned vertebral axis. The relatively broad-based pectoral fins of fast-moving, surface-feeding modern sharks are inclined anterodorsad at a more or less fixed angle, serving to counterbalance the downward thrust component of the tail. Although the vertebral axis of pleuracanths was slightly upturned (heterocercal), it is not clear from the published restorations

that the ventral caudal fin rays were markedly longer than those along the dorsal edge of the tail. If the lower rays were much longer and more flexible, then the heterocercal tail would have tended to direct the body toward the bottom.

The long, relatively narrow-based archipterygial pectoral fins of the pleuracanths do not appear to have been fixed at an angle to offset a downward component of the tail thrust; instead, they appear to have been mobile structures. Thus the caudal and pectoral fin structure of pleuracanths could have served to direct the body toward the floors of ponds, lakes, or streams and to keep it there against the action of currents, as the fish maneuvered slowly.

Dollo (1906, p. 2) discussing the pleuracanths, said: "Adaptation to benthal life—in fresh water—as proven by the gephyrocercal heterocercal (or secondarily diphycercal!) tail and the archipterygium." He compared them with lungfishes in this regard, but offered no further discussion in support of his interpretation. The foregoing stratigraphic and morphologic evidence may help, at least in part, to substantiate his conclusions.

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LAND DRAINAGE AND THE WATER TABLE IN SOUTHERN MICHIGAN AND NORTHERN INDIANA

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Introduction

In America, the practice of artificial land drainage with a view toward reclaiming land for agricultural purposes is as old as the United States itself. By 1950, the U. S. Department of Agriculture reported that 103 million acres of farm land on about 2 million farms in 40 states had been subjected to some type of land drainage (Wooten and Jones, 1955, p. 480). Much land in the states bordering the Great Lakes has been made suitable for the growing of certain crops, and Michigan, alone, has tens of thousands of acres of valuable agricultural land under the control of some district or county drainage enterprise.

The avowed purpose of land drainage is to reduce surface and subsurface water to an amount that will produce the requisite moisture conditions in soil used for agricultural purposes. In many instances, this end cannot be satisfactorily accomplished without the lowering of the water table. Thomas (1951, p. 194) states: "In Michigan about 14,000 square miles of land has been subjected to artificial drainage, accomplished by about 23,000 miles of open or tiled ditches. The regional water table has been lowered significantly in about one-third of this area, where 90 per cent of the drainage ditches are located."

In this paper the situation in Homer Township, Calhoun County, Michigan, is presented as an example of the effect of more than 50 years of artificial drainage on the regional water table. The condition in Homer Township is not unique; it is used as the basis for a more general discussion of the problem of land drainage and the water table in much of southern Michigan and northern Indiana.

Principles of Artificial Drainage

An excellent account of the principles of land drainage, entitled "Water" (Edminster and van Schilfgaarde), appeared in *The Yearbook of the Department of Agriculture* for 1955, and there is little this

writer can add to that account. Only one or two points need emphasis because of their importance in the present discussion. Of greatest significance is the statement that "essentially any one drainage problem must be considered as a combination of surface and subsurface water removal. They are interdependent . . ." (p. 491). In other words, ground water and surface water are so intimately related that they cannot be treated as separate entities in the near-surface zone.

In humid regions, land drainage is practiced wherever the terrain is too flat to permit efficient surface runoff or where the soil texture is such that its permeability is too low to permit sufficient internal drainage for optimum growing conditions. Surface water is removed by systems of open ditches, whereas subsurface drainage is accomplished mainly by networks of buried tile systems which usually drain into a surface channel.

Drainage ditches not only remove surface water but subsurface water as well. In humid regions most streams are effluent; that is, their flow is maintained by the addition of water from the ground water reservoir. A drainage ditch is an artificial stream and is also effluent in humid regions.

The rate of discharge of ground water to surface drainage lines is dependent in part on the hydraulic gradient, the ratio between the difference in elevation of two points on the water table, and the distance between them (see Ferris, 1950, for a quantitative treatment of hydraulics of drainage ditches). The hydraulic gradient remains constant so long as the factors which control it remain constant.

An increase in the hydraulic gradient increases the rate of flow of water toward the surface points of discharge. One way in which the hydraulic gradient can be increased is to increase the number of surface drainage lines, thereby reducing the distance that subsurface water must flow before it intersects a surface channel. The hydraulic gradient may also be increased by deepening existing drainage lines, although the effect of such action is not a permanent steepening of the previous gradient because the water table will tend to restore its former condition of slope, but at a lower level. Drainage ditches influence the water table in a manner similar to rows of discharging wells spaced so that there is mutual interference in their respective cones of depression. In both cases, wells or ditches, the water table is lowered parallel to itself as the discharge is increased, although the time necessary for equilibrium conditions to be reached will be long

if the porous medium has a low permeability, but quite rapid if the permeability is high.

Homer Township: A Case History

An example of the effect of surface drainage on the water table is the situation in a rather small, yet typical, area in southern Michigan which the writer had occasion to study in some detail in the fall of 1954.

General setting.—Homer Township lies in the southeastern corner of Calhoun County, Michigan. The topography is controlled chiefly by constructional land forms produced by the advance and retreat of the Saginaw lobe during the Wisconsin stage of the Pleistocene. Maximum relief for the 36-square-mile tract is about 100 feet. Annual precipitation is about 33 inches, part of which is in the form of snow. Mean annual temperature is about 46° F. with extremes ranging from −20° F. in winter to 95° F. in summer. Most of the land has been used for agriculture since the area was settled well over 100 years ago (Rogers and Smith, 1919, p. 10).

Geologic setting.—The glacial deposits of Homer Township may be classified into the (1) outwash sands and gravels of lowlands, (2) lacustrine clays and silts of old lake bottoms, (3) muck and peat deposits, and (4) glacial till of the uplands (Fig. 1).

The stratified deposits are mostly in the form of outwash plains or valley trains underlain by sand and gravel. Shallow depressed areas within the outwash plains are common, and they probably represent ice block pits. Some contain lakes—as, for example, Homer Lake—whereas others contain old lake sediments, peat, or muck.

The morainic tracts are rolling to hilly and are underlain by an unusually sandy till which contains less than 5 per cent clay. The permeability of the sandy till is an important factor associated with the artificial drainage history of the area.

Soils.—The soils of the area are closely related to the various types of surficial materials and their topographic situations (Rogers and Smith, 1919). The well-drained soils are the Coloma and Bellefontaine series of the morainic tracts, and the Fox and Plainfield series of the outwash plains (Fig. 1). High permeability in these soils accounts for their good drainage characteristics.

Poorly drained soils consist of the Homer and Clyde series of the shallow depressed series of the modern floodplains. Table I summarizes the relationships of the soils to the geological features.

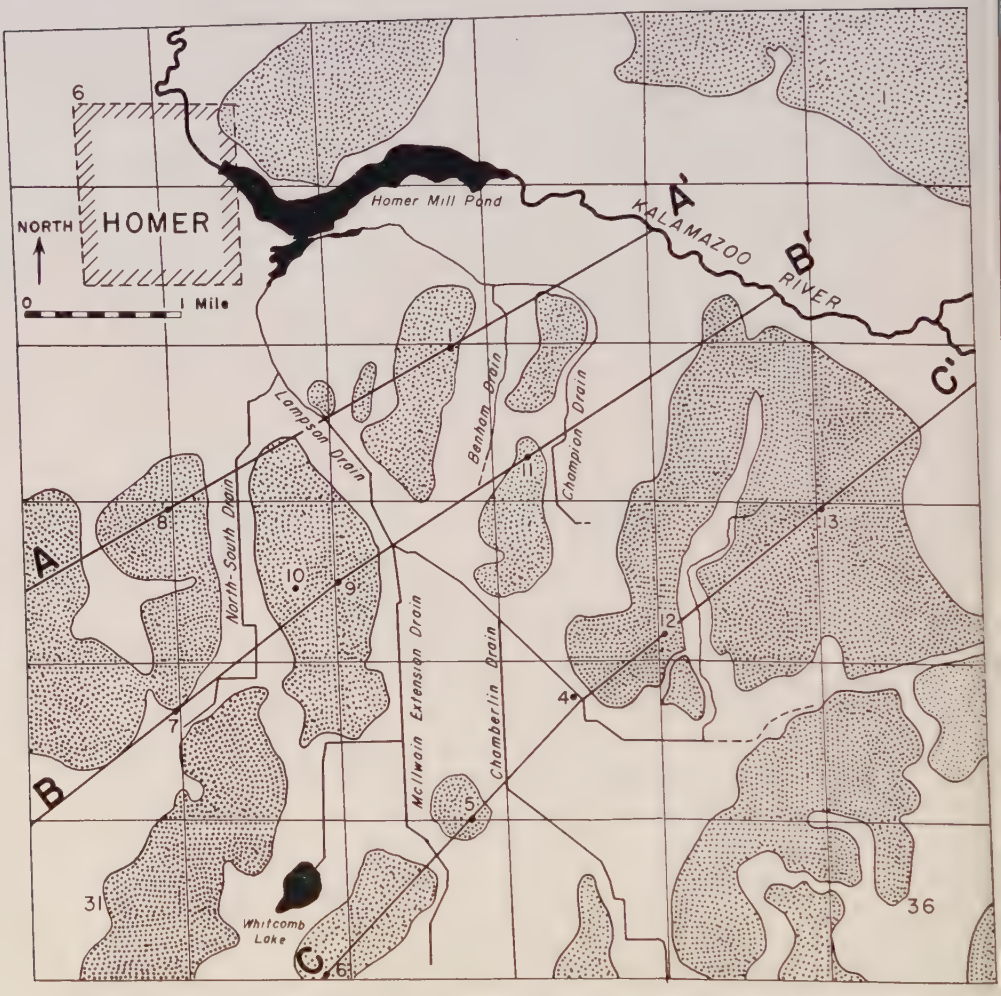

FIG. 1. Map of Homer Township in Calhoun County, Michigan. Stippled area shows distribution of sandy morainic soils of the Coloma and Bellefontaine series. For topographic cross sections and water table configuration, see Figure 2. Numbers indicate points where depth to water table measurements were made. (Based on U. S. Geologic Survey Maps, Homer and Spring Arbor Quadrangles, 1949 editions. Information on soil distribution based on U. S. Department of Agriculture Soil Survey of Calhoun County by Rogers and Smith, 1919).

TABLE I

RELATIONSHIP OF THE SOILS OF HOMER TOWNSHIP TO THE GEOLOGIC FEATURES

Soil series (Rogers and Smith, 1919)	Parent material lithology	Physiographic setting	Natural drainage
Coloma	Very sandy glacial till (less than 5% clay)	Rolling to hilly morainic tracts	Good to excessive
Bellefontaine	Sandy, bouldery, till (12–13% clay content)	Rolling to hilly morainic tracts	Good to excessive
Fox	Sand and gravel	Undulating to flat outwash plains or terraces	Good
Homer	Sand and gravel	Slightly depressed areas in outwash plains	Poor
Plainfield	Fine to medium sand	Level outwash plains and lake and stream terraces	Good to excessive
Clyde	Sand and gravel or loamy till	Shallow depressed areas to level	Poor
Griffin	Sand and gravel	Modern flood plains	Good where not subject to overflow
Wabash	Sands, silts, some gravels and organic material	Flat surfaces of modern flood plains	Poor

Drainage.—A random system of more than 20 miles of drainage ditches has been constructed in Homer Township over the past 65 years (Fig. 1). Most of the ditches converge toward the north and eventually reach the Homer Mill Pond, an artificial lake created by an old power dam on the Kalamazoo River. The drainage ditches follow natural topographic lows that either carried glacial meltwater or were occupied by standing water bodies during the retreat of the last ice sheet. The chief reason for the drainage ditches appears to be related to the high moisture content of the lowland soils, which, because of the high regional water table, are too wet for early spring plowing. It is significant that all the lowland inorganic soils except the Clyde series are developed on relatively permeable parent mate-

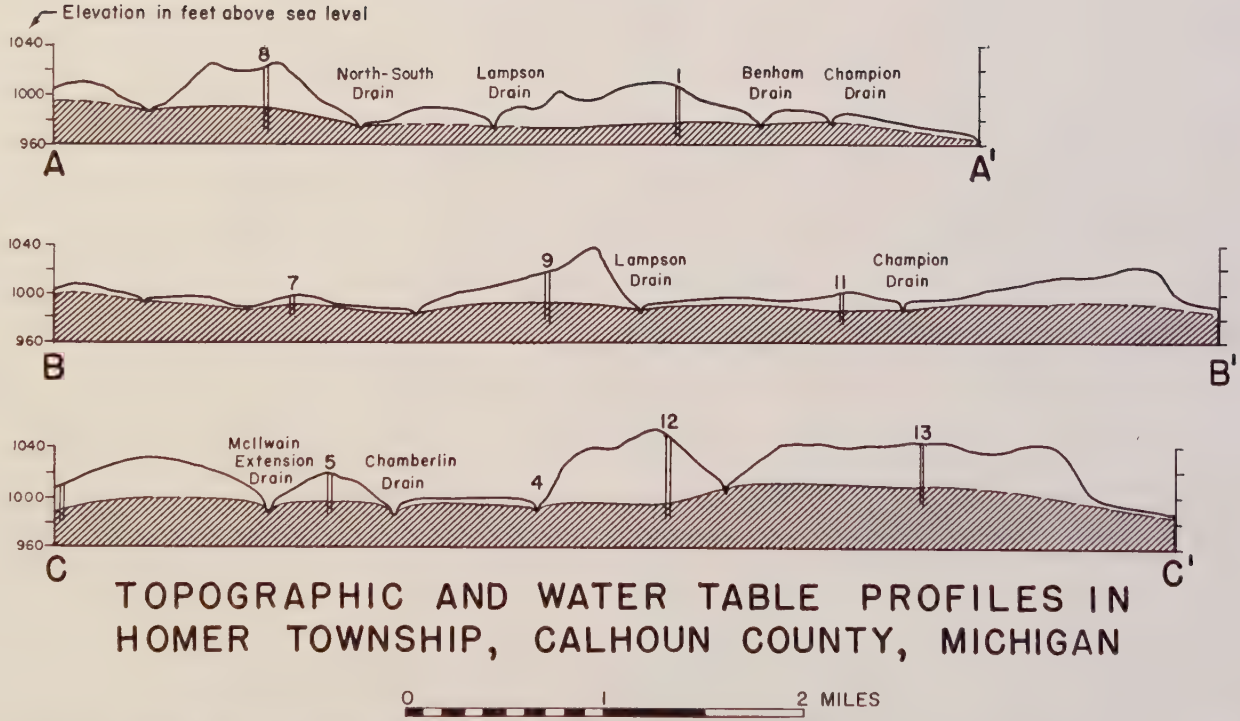

FIG. 2. The water table in Homer Township, October, 1954. The water table lies at the top of the cross-hatched zone. Numbers along profile indicate points where water levels were measured in October, 1954. (Topography based on U. S. Geologic Survey Maps, Homer and Spring Arbor Quadrangles, 1949 editions.)

rials (see Table I). Drainage is needed for them, not because of their high clay content which produces low permeability, but rather because of the nearness of the regional water table to the surface. Soils of the Clyde series and some of the muck soils require drainage owing to their low permeability as well as their low-lying topographic position.

Effect of artificial drainage. -A survey of ground water levels in October, 1954, by the writer disclosed a relatively flat water table throughout the entire area of Homer Township (Fig. 2). That the water table must have been higher in the past is attested to by the fact that windmills formerly used by landowners in Homer Township are no longer in use. One such well near the center of the west boundary of Sec. 21 is located on the upland moraine at an elevation of about 1000 feet above sea level. The depth to water in a well ¼ mile west in Sec. 20 at a slightly higher elevation is 30 feet below ground level. If it is assumed that a simple lift pump commonly powered by windmills could not have been used where the water table is greater than about 20 feet below ground surface at this elevation, the water table beneath the windmill site must have fallen several feet since the windmill ceased to operate. Other similar situations exist.

It is possible that water table fluctuations occur as the result of yearly variation in precipitation, but in Homer Township the low water table beneath the sandy morainic tracts of the uplands must be attributed in a large part to the increased surface runoff induced by the many miles of effluent drainage ditches. Not only do they remove excessive surface water during the spring break-up, but they also draw on the ground water reservoir for their base flow in the middle and late summer months during periods of extended drought. As a result, spring planting is accomplished earlier, but soil moisture may be depleted later in the growing season because ground water is still discharging into the open ditches.

Solutions to the Drainage Problem

The writer realizes the danger involved in generalizing from incomplete data. The geologic situation in Homer Township is not unique, however, in view of the fact that the Saginaw lobe covered several counties in south-central Michigan and northern Indiana. In both states the sandy and permeable soils of the Coloma series have been mapped by the U. S. Department of Agriculture. It

seems, therefore, that some degree of generalization for the area covered by the Saginaw lobe is warranted. Caution must be exercised, however, in applying the Homer Township example to dissimilar areas, thus arriving at false or unsound conclusions. This writer further realizes that artificial land drainage is necessary in many areas and, indeed, is mandatory in some for the purpose of proper and economic development of agriculture land.

Diametrically opposed interests are concerned with artificial land drainage. We are concerned here, not with the relative merits of land utilization for agriculture as opposed to waterfowl breeding grounds, but rather with the agricultural interests in relationship to the conservation of ground water. With the increasing demands placed on ground water, it would seem advisable to devise a means of satisfying both interests. At least one author (Ferris, 1949, p. 263) has suggested a solution to the problem, although the present writer has not observed its widespread application in Michigan.

The solution lies in the control, rather than the abolition, of drainage ditches. They would be opened during the spring runoff in order to permit early planting in certain fields but would be closed or partly closed for the remainder of the growing season, thus reducing unnecessary depletion of the ground water moisture, which in turn would maintain higher water tables.

Thousands of miles of irrigation ditches in the western United States are regulated in this manner, and there seems to be no good reason why such a practice could not be adopted in the more humid regions. To be sure, problems would arise in connection with authority for regulating the gates, but possibly a system of observation wells strategically located within the area affected by the drainage ditches could provide the basis for such decisions.

Also, check gates would reduce velocities in the ditches to the point where sedimentation would necessitate more frequent cleaning of the ditches. But in spite of these added problems connected with the regulation of flow in the ditches, it seems to this writer that they are justified in view of the benefits to be derived, not only to ground water conservation, but also to agronomy.

All this points up the growing need for a more complete understanding of geological conditions by people concerned with the planning of artificial drainage systems. Too often the designs of drainage

systems are based on incomplete knowledge of the geological factors, or they are constructed for the purpose of political expedience. Neither practice can be condoned if we are to utilize our natural resources to their fullest extent.

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QUANTITATIVE ASPECTS OF EVAPORITE DEPOSITION

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Introduction

The oceanographic and chemical depositional characteristics of the evaporite basins have been summarized by Scruton (1953). He compared modern estuaries connected by a restricted channel to the open ocean, inasmuch as there are no typical representatives today of the marine evaporite basins that are so well represented in the geologic column of North America (Krumbein, 1951; Sloss, 1953). Scruton extended the hypothetical reflux mechanism of King (1947) by analogy to modern hydrographic conditions in estuaries in which the water balance favors evaporation over water precipitation and terrestrial inflow. He was able to outline the gross distribution of brine density, currents, and evaporite mineral deposition to be expected with the establishment of dynamic equilibrium.

But the exact pattern and thicknesses of mineral deposition cannot be predicted with certainty in view of the metastable balance in the complex of factors controlling equilibrium. These factors include rates of evaporation, water precipitation, terrestrial inflow, tidal height, wind stress, influx and reflux brine current flow, and the effect of mixing brines of differing density in channeled flow areas. For ancient evaporite deposits we can reconstruct only approximately at best the geometric characteristics of the depositional basin that in part control brine circulation, such as shape, depth, and shoreline configuration of the basin, and width, depth, and length of the feeding channel or channels. In any reconstruction of ancient deposits the geometric characters are inferred from the distribution of the evaporite deposits, and the reliability of their reconstruction depends directly on the validity of the theory developed to explain the patterns of mineral deposition.

The present study predicts the sequence and distribution of mineral precipitates from the data of Usiglio (1849) for the evaporation of sea water and illustrates the quantitative aspects of the rate

of mineral deposition for a simplified idealized evaporite cycle. This study tests, in other words, the validity of the quantitative approach in the features observed in the laminated evaporites.

The Chemistry of Evaporation of Ocean Brine

Ocean brine is remarkably uniform in its content of the more soluble elements, except in marginal areas where the quantities are affected by the terrestrial runoff. The concentration of dissolved salts averages very closely 34 parts per thousand, represented for the most part by the following ions (Harvey, 1955, p. 131):

Cl	55.2
Br	0.19
SO_4	7.7
HCO_3 and CO_3	0.35
Na	30.4
K	1.1
Ca	1.16
Mg	3.7

This constancy is all the more remarkable in view of the rather delicate and intricate balance between the following systems: atmosphere–sea water, sea water–sea floor, and sea water–organic activity. Changes in the balance of these systems are for the most part compensating, so that equilibrium is maintained. Only under very special conditions is this equilibrium disturbed, as during the formation of evaporite deposits.

In an oceanic basin having restricted circulation with the open ocean and where the water balance favors evaporation over rainfall and terrestrial inflow, there will be a progressive increase in the concentration of salts in the basinal brine. This increase in concentration will continue as long as evaporation is the dominant controlling factor. When the concentration becomes somewhat greater than normal, evaporite minerals will begin to precipitate from the more dense brine. The relatively minor iron oxides are ignored in this treatment inasmuch as they are volumetrically insignificant. No data are available for the start of carbonate mineral precipitation, but it begins before the concentration reaches 1.82 times normal. The sequence of mineral precipitation is shown in Table I and Figure 1.

Usiglio originally showed the weight of minerals precipitated from the evaporation of 5 liters of ocean brine to the density values in the

left-hand column. Clarke (1924, p. 220) recalculated these to the basis of 1 liter of brine. In Table I, Clarke's values have been converted to the weight precipitated for each milliliter of brine evaporated within each density interval because these values are directly applicable to geologic problems pertaining to evaporite mineral deposition.

To apply the data to an evaporite sequence one must know or estimate the proportional weights or thicknesses of minerals, rate of

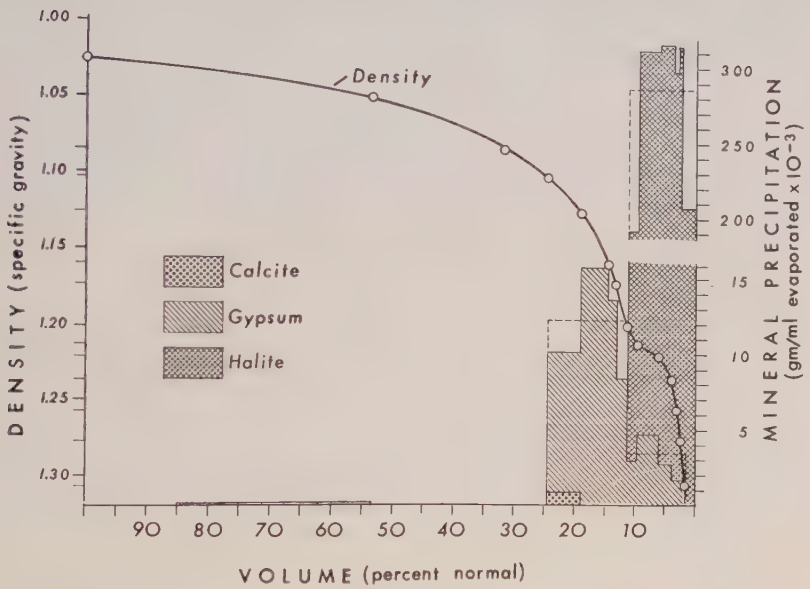

FIG. 1. The change in density, volume, and weight of minerals precipitated during the evaporation of sea water. The dashed lines represent the average rates of mineral precipitation in the corresponding volume and density intervals. Data are from Table I, modified after Clarke (1924) and Usiglio (1849).

brine evaporation, and density of the brine. None of these is independent of the other two. Thus, if the proportions of minerals are determined for an evaporite sequence, some idea is gained of the density field that the mineral association represents (Fig. 1). The smaller the evaporite sequence studied, the more exactly can the corresponding brine density from which the minerals precipitated be estimated. Where only one anhydrite-dolomite or one anhydrite-halite lamina is considered, the range of equivalent brine densities

can be estimated with considerable exactness, provided that the minerals were deposited from the evaporation of concentrated sea water.

For all marine evaporites one should assume that the minerals were deposited from an oceanic brine at some particular stage of concentration unless there is convincing evidence to the contrary.

TABLE I

EVAPORATION OF SEA WATER—PROPERTIES OF THE BRINE AND WEIGHT OF MINERALS PRECIPITATED FROM THE EVAPORATION OF 1 MILLILITER OF BRINE

Density	Volume, liters	Solute, grams	Salinity,* ‰	Concentration, times normal	Minerals precipitated, grams × 10^{-3}		
					$CaCO_3$	$CaSO_4$	NaCl
1.0258	1.000	38.45	37.5	1.00	—	—	—
1.050	0.533	38.38	68.5	1.82	0.137	—	—
1.084	0.316	38.38	111.9	2.98	tr	—	—
1.1037	0.245	38.38	141.0	3.76	tr	—	—
1.1264	0.190	37.78	157.1	4.19	0.963	10.20	—
1.1604	0.1445	37.20	222.5	5.93	—	15.80	—
1.1732	0.131	37.02	240.5	6.40	—	13.62	—
1.2015	0.112	36.80	274.0	7.30	—	8.42	—
1.2138	0.095	33.54	291.0	7.75	—	2.99	192
1.2212	0.064	23.69	305.2	8.13	—	4.76	312
1.2363	0.039	15.58	325.7	8.68	—	2.80	316
1.2570	0.030	12.88	339.5	9.05	—	1.64	298
1.2778	0.023	10.50	357.5	9.53	—	—	315
1.3069	0.016	8.47	399.0	10.64	—	—	207

* Salinity calculated as the weight proportion of the dissolved solids per kilogram of brine having the density shown in the left-hand column. These values closely approximate those obtained by extrapolation of the density-salinity curve of Harvey (1955, pp. 128–130) into high salinities.

Expected exceptions to this principle include the inflow of terrestrial water into the evaporite basin, but in general this condition can be recognized by an unusual association of evaporite minerals (halite and dolomite, but no anhydrite—cf. Table I and Fig. 1) or when the calculations indicate that the original density was much less than that of normal marine water. In many instances the adduced conditions of evaporite deposition are not a unique solution for the known variables; most are only scientifically reasonable.

The rate of brine evaporation is a climatic factor and is equivalent to the total evaporation minus rainfall and terrestrial inflow during a specified period, conventionally a year. A fairly reasonable and accurate estimate of evaporation can be made from available meteorological data for arid and semi-arid regions, the indubitable climatic setting for evaporite basins. Caution must be exercised in estimating the rate of evaporation inasmuch as most data are determined by pan evaporation uncorrected to reservoir surface conditions. A correction factor of 0.70 should be applied to the raw pan data (Wisler and Brater, 1949, p. 150).

The maximum evaporation rate from the oceans is 52 ± 6 inches per year in the lower equatorial latitudes (Sverdrup, 1951, p. 1072). The average of six semi-arid and arid reservoir evaporation rates, ranging from 51 to 123 inches per year, is 88 inches (Wisler and Brater, 1949, p. 151; Follansbee, 1934); thus, a value of 70 inches (185 centimeters), a mean of oceanic and reservoir evaporations, is considered the most reasonable for ancient evaporite basins envisaged as semi-marine bodies of water in a region of arid climate. A further factor affecting evaporation is that brines of high density do not evaporate as readily as those of low density, owing to a change in heats of solution (Randell and Bissen, 1920; Stearn and Smith, 1920). An additional correction factor of 0.90 in the density range above 1.21 might be applied where an evaporite sequence composed largely of halite and potash salts is being considered. Rainfall and terrestrial runoff might further reduce the effective evaporation rate to about 60 inches (152 centimeters) per year. For convenience, 150 centimeters per year are used in subsequent calculations.

Mechanism of Evaporite Deposition

It becomes increasingly clear as additional data are obtained about the nature and distribution of evaporite minerals in ancient deposits that the most logical mode of deposition is the reflux mechanism advanced by King (1947) and further clarified by Scruton (1953). The cross-section geometry of the evaporite basin, the characteristics of current inflow and basin circulation, and the distribution of densities and minerals deposited are illustrated in Figure 2.

To balance the loss of water due to evaporation from the surface of the basinal brine, an influx of relatively low-density (ca. 1.025) oceanic brine flows from the open ocean into the basin through the

connecting channel and spreads out upon the surface as a thin water wedge. The flow in the influx wedge is toward the distal edges of the basin during which the density increases owing to surface evaporation and mixing with the denser basinal brine. The position of the lines of equal density in the surface water will effectively delineate the type and distribution of mineral deposition (see Figs. 1 and 2 and Table I).

The distribution of brine densities on establishment of dynamic equilibrium, as adduced from detailed analyses of the Salina evaporites of the Michigan basin, strongly favors a change from horizontal density stratification *of the brine* near the inlet to a near vertical stratification in most of the remainder of the basin as envisaged by Scruton (1953, p. 2506; also see Fig. 2). This situation indicates that friction at the interface between the influx and basinal waters and

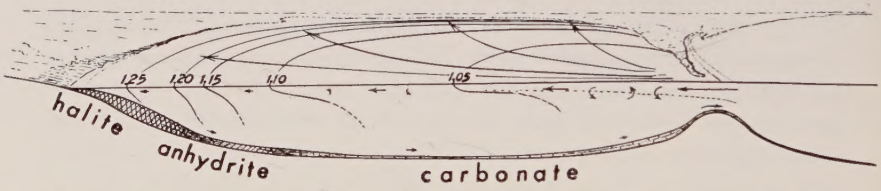

Fig. 2. Cross section of an evaporite basin showing brine circulation (arrows), lines of equal brine density in cross section and on surface of the basinal brine, and distribution of evaporite mineral deposition produced when the brine density distribution is as shown.

constriction of the inlet channel produce strong mixing with recycling of the basinal brine. Mixing and recycling do not negate treatment of evaporite mineral deposition from Usiglio's data for "normal sea water." Some of the more soluble potassium and magnesium chlorides and bromides will become more concentrated by this process than is normal, but mixing will precipitate from the influx waters a proportion of those salts whose dissociation products are exceeded in the mixed brine solutions.

The fact that most evaporite mineral deposits contain none or only a trace of the more soluble salts (Dellwig, 1955, pp. 97–98) indicates that in the normal evaporation processes their dissociation products are not exceeded. Either there is sufficient reflux leakage across the sill to prevent saturation of the basinal brine with these ions, or the normal evaporite cycle is interrupted by refreshening before saturation is reached. Possibly both mechanisms are effective,

but the characteristic lamination of evaporites supports the idea of periodic refreshening (Briggs and Lucas, 1954).

Anhydrite-Dolomite Laminae

Each lamina of anhydrite-dolomite[1] from the Permian Castile formation of Texas consists of a gradational layer composed of dolomite at the bottom and anhydrite at the top (Udden, 1924). The boundary of each lamina is marked by a thin petroliferous film. The thickness of the anhydrite-dolomite laminae ranges from 0.2 to 7.0 millimeters, and averages 1.63 millimeters, the most common variation being between 0.5 and 2.0 millimeters. Udden assumed each lamina to be an annual layer much like those of varved clays, and subsequent writers have referred to Udden's data for the annual rate of anhydrite deposition (King, 1947; Ogniben, 1955).

A test of the assumption that the lamina represent annual evaporite deposits can be made from the data of Usiglio. The petroliferous film indicates that the deposition of most laminae represents a complete cycle such that the surface waters were sufficiently normal at the start of the cycle to support planktonic organisms.

The absence of halite indicates that the brine was not concentrated by evaporation to a density greater than 1.20 and probably on the average did not exceed 1.16 (Fig. 1). During deposition of each lamina the decrease in volume of the surface brine above the place on the sea floor where the laminae were deposited was about 85 per cent from that of normal sea water (Fig. 1). This presumably represents an annual evaporation of 150 milliliters. If the evaporation rate was constant during the course of the year, carbonate minerals were deposited during 89 per cent of the year (density range 1.025–1.104), carbonate and sulfate during about 7 per cent of the year (1.104–1.126), and sulfate alone during the remaining 4 per cent of the year (1.126–1.1604). Thus, 134 milliliters was evaporated coeval with carbonate precipitation, 10 milliliters with carbonate and sulfate precipitation, and 6 milliliters with only sulfate precipitation. These figures multiplied by the appropriate rates of precipitation (Table I, Fig. 1) give the gram weights of the minerals deposited. It is necessary then to convert gram weights to volume, and volume to thickness. The gram weight divided by the density (assuming no porosity)

[1] The carbonate mineral was not identified with certainty by Udden (1924, Figs. 1 and 2), but presumably it is dolomite.

gives the volume, and the numerical value of the volume is directly convertible to thickness if we consider the mineral deposition on a unit area (square centimeter) of the sea floor. The calculations are summarized in Table II.

The calculated thickness has geological significance only in order of magnitude, since the conditions governing mineral deposition were no doubt much more complex than in the simplified model used for convenience of calculation. It is indeed noteworthy, however, that the calculated thickness of an anhydrite-dolomite annual lamina derived from Usiglio's data falls within the range of the most common thickness measured in the Castile formation. That the calculated thickness is approximately one-half the value of the average thickness observed may indicate that other factors controlling mineral deposi-

TABLE II

CALCULATIONS OF THE THICKNESS OF AN ANHYDRITE-DOLOMITE LAMINA

Density range	Mineral phase	Rate of precipitation, grams/milliliter evaporated	Amount of evaporation, milliliters	Weight of precipitate, grams	Volume of precipitate, cubic centimeters	Thickness deposited, centimeters
1.025–1.104	Carbonate	1.8×10^{-7}	134	2.43×10^{-5}	0.9×10^{-5}	0.9×10^{-5}
1.104–1.126	Carbonate	9.63×10^{-4}	10	9.63×10^{-3}	3.56×10^{-3}	3.56×10^{-3}
1.104–1.126	Sulfate	10.20×10^{-3}	10	10.20×10^{-2}	3.50×10^{-2}	3.50×10^{-2}
1.126–1.160	Sulfate	15.80×10^{-3}	6	9.47×10^{-2}	3.25×10^{-2}	3.25×10^{-2}

Total thickness, 0.0711 cm.

tion should be considered, such as the contribution of nonevaporite carbonate deposition and the mixing of the influx and basinal brines. The proportion of carbonate minerals in the calculated lamina is only 5 per cent, whereas Udden observed that the proportion in the Castile formation is approximately 25 per cent. It is significant to note also that the maximum lamina thickness observed in the Castile (7 millimeters) is but slightly exceeded by the calculated thickness obtained when the brine ranges in density only from 1.104 to 1.160, which could arise by mixing of influx and basinal brines, or by unusually low volumes of periodic influx.

The theoretical treatment of the deposition of evaporite minerals greatly strengthens the assumption that the anhydrite-dolomite laminae in the Castile formation of Texas represent annual evaporite deposits. The periodic refreshening of the basinal waters may be a